THE UNIVERSITY OF ALBERTA

THE BIOLOGY OF THE LYNX, *FELIS* (*LYNX*) *CANADENSIS* (KERR) IN ALBERTA AND THE MACKENZIE DISTRICT, N.W.T.

by

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A THESIS

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "THE BIOLOGY OF THE LYNX, *FELIS* (*LYNX*) *CANADENSIS* (KERR) IN ALBERTA AND THE MACKENZIE DISTRICT, N.W.T." submitted by Constantinus Gerhard van Zyll de Jong in partial fulfilment of the requirements for the degree of Master of Science.

ABSTRACT

A study of the biology of the lynx (_Felis_ (_Lynx_) _canadensis_) in Alberta and the adjacent Mackenzie District, N.W.T. was conducted from September 1961 to the summer of 1963. The lynx population was at a high level during this period. Information was obtained from 118 carcasses.

Comparison of age and sex ratios of different areas of collection indicated a movement of yearlings into unfavorable habitats (agricultural areas, prairies, cities, etc.) from surrounding more favorable habitats. A preponderance of males was found in these unfavorable habitats, perhaps indicating greater mobility of yearling males.

Standard measurements and weights are given. Selected skull measurements differed significantly from similar measurements from Newfoundland, but are probably not different from Alaska measurements.

Ossification of the long bones of the fore limb was studied and found to be useful as an ageing method. Growth in length of the humerus appeared to terminate around 24 months of age, but complete ossification is not attained until the third year of life.

Eruption and replacement of teeth were investigated and compared with available data for the European lynx (_Felis_ (_Lynx_) _lynx_).

Data and observations on molt are given; suggesting only one spring molt and attainment of the winter coat by continued growth of hair during summer and early fall.

Food analysis showed snowshoe hare (*Lepus americanus*) to be the most frequent prey species, followed by microtines.

Taenia macrocystis, *T. rileyi*, *T. pisiformis*, *Toxascaris leonina*, *Toxocara cati*, *Spirocerca lupi*, *Physaloptera praeputialis*, *Troglostrongylus wilsoni* and *Alaria* (*Paralaria*) sp. were the endoparasites collected. One ectoparasite *Monopsyllus vison* was collected.

Attainment of sexual maturity in males and females is discussed. First evidence of gonadal activity in both sexes was noted in the beginning of the second year of life. Breeding probably does not take place until the end of the second year.

ACKNOWLEDGEMENTS

I would like to thank the many people that provided lynx carcasses from various parts of the Province; without their co-operation this study would not have been possible. In this respect I am especially indebted to employees of the Fish and Wildlife Division of the Alberta Department of Lands and Forests, in particular Mr. J. G. Stelfox, Mr. W. Wishart and Mr. D. A. Clark. Special thanks is due to Mr. P. A. Rylaarsdam of Vega, who not only provided a good number of carcasses but was also very helpful during my work in the field in the summer of 1962.

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INTRODUCTION

The lynx (Felis (Lynx) canadensis) has been the object of a number of cyclic population studies which were mainly statistical in nature (e.g., Elton and Nicholson, 1942; Moran, 1949, 1953; Wing, 1953). The study of its biology and ecology has been neglected until recently. Little has been added to the literature since Seton wrote his classical work (1910), but much has been copied without critical review in later literature. The study of the biology of the Newfoundland lynx (Saunders, 1961) was the first major study of its kind undertaken in North America. The present study was begun in September 1961 and concluded during the summer of 1963. The aim was to collect and interpret data that would add to our knowledge of the biology and ecology of this carnivore. The lynx population was high and probably experienced its peak during the period of study.

MATERIALS

Letters were sent out to Alberta Fish and Wildlife personnel with a request for lynx carcasses. During the period of study 118 carcasses were collected, 114 of which were collected in 1961 and 1962, and only 4 in 1963. Most of the specimens (82) came from the Province of Alberta; the remainder came from an area within a 30 mile radius around Hay River, Northwest Territories, and the region of the lower Rabbit Skin River, northeast of Fort Simpson, Northwest Territories. Complete autopsies were done on all carcasses, and pertinent information collected.

AGE AND SEX RATIOS

Many of the Alberta specimens were collected in habitats not normally occupied by the lynx. It seems unlikely that the movement into marginal and unfavorable habitats was initiated by a scarcity of food, as is often believed. The hare population was high, and most of the lynxes had moderate to high subcutaneous and abdominal fat deposits (no quantitative assessment was made). The age and sex ratios in these areas were compared with those areas considered to be normal lynx habitat.

Alberta was divided for this purpose into a zone of mainly unfavorable habitats, (Zone 1) including most of the parklands, cultivated lands, prairies and major urban areas; and a zone of favorable or at least less unfavorable habitats,(Zone 2) including the less densely populated forested and mountainous areas (Fig. 1). The ratios of adults to yearlings to kittens were: Zone 1, 5:34:4 and Zone 2, 9:18:3. In the Northwest Territories the ratio was 10:13:13. The difference between Zone 1 and Zone 2 is highly significant (Chi square = 17.42, at the 5 percent level). A comparison of Zone 2 and the Northwest Territories shows them to be significantly different (Chi square = 9.69, at the 5 percent level). The proportion of yearlings therefore increases towards the south. The high proportion of yearlings in Zone 1 could be attributed to an abnormally high mortality among adults in this region, or a movement of yearlings into the area from Zone 2. The first explanation seems unlikely, as it would be hard to account for such a

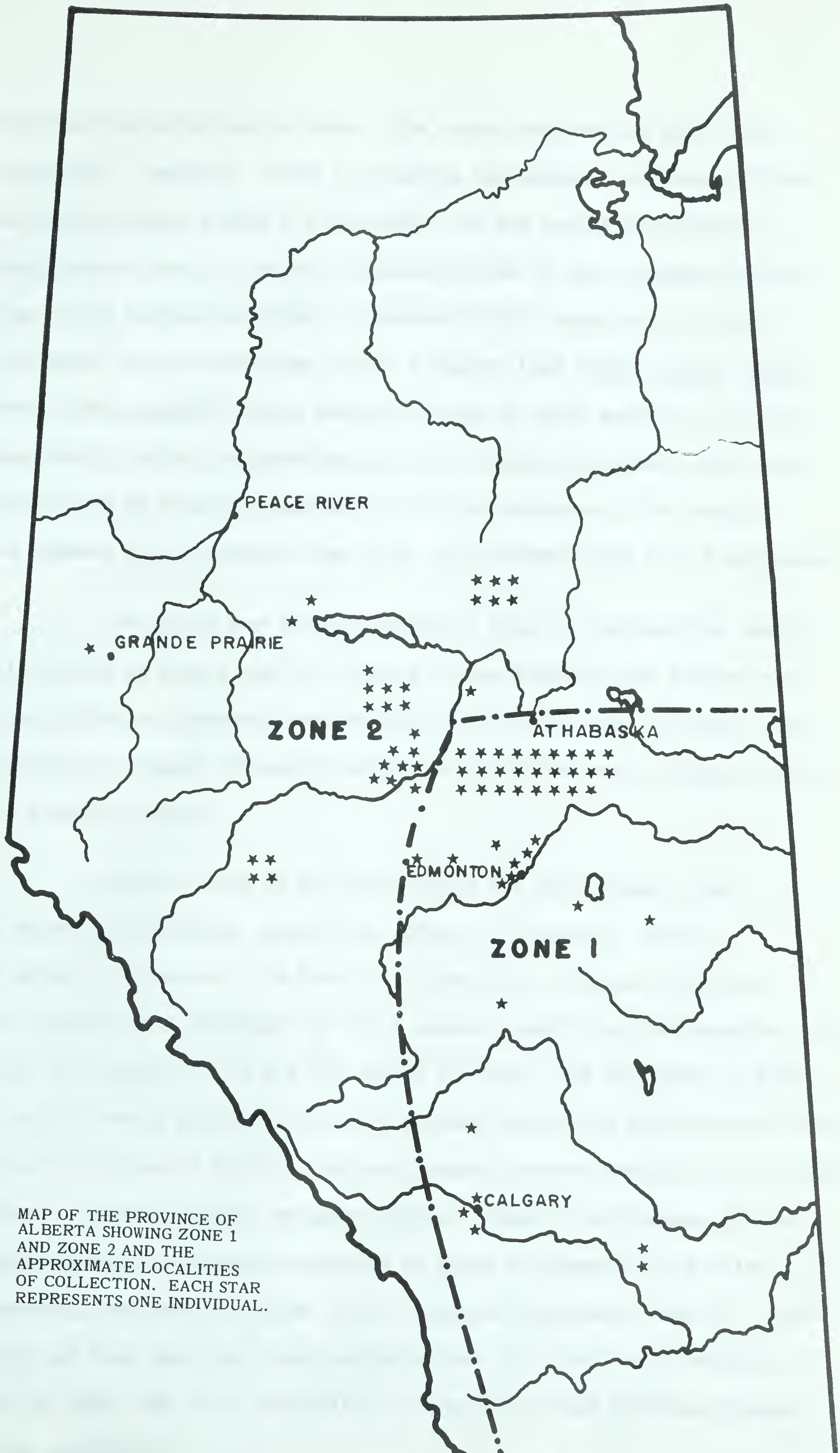


FIG. 1 MAP OF THE PROVINCE OF ALBERTA SHOWING ZONE 1 AND ZONE 2 AND THE APPROXIMATE LOCALITIES OF COLLECTION. EACH STAR REPRESENTS ONE INDIVIDUAL.

disproportionate mortality rate. The second explanation seems more acceptable. Saunders' (1963 a) tracking and movement studies indicate that adult lynxes occupy a home range, and are relatively sedentary. Young animals were on several occasions noted to move through occupied home ranges without settling. Lindemann (1950) reported a distinct attachment to the home range in the European lynx (*Felis* (*Lynx*) *lynx*). Young lynxes probably leave the home range of their mother at, or perhaps shortly after the breaking up of the family in spring. This age group would be chiefly responsible for the extension of the range. The figures just presented seem to be in agreement with this hypothesis.

The ratios may further suggest a drop in reproduction during this period in Zone 1 and 2. Graders at the Edmonton Fur Auction related to Fuller (personal communication) that the number of pelts from kittens had dropped decidedly during the 1961-1962 season compared with the previous season.

The sex ratio in the three areas was as follows: Zone 1, 29 males : 14 females; Zone 2, 18 males : 12 females; N.W.T., 23 males : 13 females. In Zone 2 and the N.W.T. the sex ratios are not significantly different at the 5 percent level from the expected 50:50 ratio (Chi square = 1.2 and Chi square = 2.78). The sex ratio in Zone 1 is significantly different at the 5 percent level from the expected 50:50 ratio (Chi square = 5.22). This may suggest greater mobility of yearling males. In Newfoundland, movement studies showed no difference in the average distance between recaptures of males and females (2.0 miles), if one male, that moved 64 miles is not included (Saunders, 1963 a). This study was done when the lynx population was at a low level (Saunders, 1961 p. 105), and it is possible that lynxes are more stationary under these conditions.

PHYSICAL CHARACTERISTICS

Measurements and Weights

Standard measurements and weights were taken whenever possible. In some cases the condition of the carcasses allowed only one or two of the measurements to be taken.

Standard measurements of 12 adult males and 11 adult females are reported in Table 1. In 7 of the males and 8 of the females measurements were taken from skinned carcasses, and no weights were obtained. Standard measurements and weights of immature lynxes are listed separately in Table 2.

The height at the shoulders and at the hip joint was measured in three adult males and three adult females; these averaged 55cm and 59cm in the males and 52cm and 56cm in the females.

Selected measurements taken from a total of 105 skulls are listed in Tables 4 (adults) and 5 (immatures). Measurements were made with a pair of steel calipers graduated in millimeters. All measurements are to the nearest millimeter.

The measurements taken were: basal length, condylo-basal length, zygomatic width, canine width and maxillary tooth row.

Basal length is the distance between the anteriormost part of the foramen magnum and the anterior border of the premaxilla.

TABLE 1. STANDARD MEASUREMENTS (cm) AND WEIGHTS (kg) OF ADULT LYNXES

Adult Males	Total Length	Tail	Hind Foot	Ear	Weight
Mean	92	11	23	7.6	10.55 (23.2 lbs.)
Extremes	85-105	10-12	22-25	7.2-8	9.08-11.80 (20-26 lbs.)
Standard deviation	5.45	0.64	0.96	-	.54 (1.18 lbs.)
Sample size	12	12	12	2	5
Adult Females					
Mean	86	10	22	7.3	8.7 (19 lbs.)
Extremes	78-95	8-11	21-24	7.2-7.4	7.5-9.5 (16.5-21 lbs.)
Standard deviation	4.60	1.09	.91	-	-
Sample size	11	11	11	2	3

TABLE 2. STANDARD MEASUREMENTS (cm) AND WEIGHTS (kg) OF IMMATURE LYNXES

Males	N	Estimated age	Total Length	Tail	Hind Foot	Weight
	1	8 months	77	9	21	-
	1	13 months	90	13	22	-
	2	17 months	93	11	24	10.90
	6	18 months	88	11	23	-
	5	19 months	88	11	23	-
	5	20 months	88	11	23	-
	1	21 months	92	13	23	-
	3	24 months	92	11	23	9.99
	2	31 months	88	12	24	-
Females						
	1	6 months	68	10	17	-
	1	7 months	69	8	19	-
	1	14 months	85	10	20	5.68
	1	17 months	91	8	24	9.08
	1	18 months	82	9	22	-
	2	19 months	86	12	22	-
	2	21 months	87	11	22	-
	1	27 months	95	11	23	9.08
	1	29 months	84	8	22	7.49
	1	31 months	82	11	22	-

TABLE 3. STANDARD MEASUREMENTS (cm) AND WEIGHTS (kg)

FROM OTHER REGIONS IN NORTH AMERICA

Locality	Sex	Total Length	Tail	Hind Foot	Ear	Weight	Author
Newfoundland	Male (adults & yearlings)	$\bar{x}$ 89	10	23	-	10.69	Saunders 1961
	Range	74-107	5-13	20-26	-	6.36-17.25	
		n 96	96	95	-	93	
	Female (adults & yearlings)	$\bar{x}$ 84	10	22	-	8.58	
	Range	76-97	8-12	19-25	-	4.99-11.80	
		n 89	95	89	-	91	
Wyoming	1 Male	97	13	26	8.6	9.87	Halloran et al., 1959
	1 Female kitten	76	9	22	7.6	4.48	
Wisconsin	1 Male	83	9	21	6.2	8.62	Doll et al., 1957
	1 Female	98	-	24	-	12.26	Schorger, 1947
Ontario	1 Male	83	12	22	7.4	9.99	van Zyll de Jong, 1961
	1 Male	85	10	24	8.3	10.89	pers. obs.

TABLE 4. SKULL MEASUREMENTS OF ADULT LYNXES (mm)

Males	Basal Length	Condylo-basal Length	Zygomatic Width	Canine Width	Maxillary Tooth Row
Mean	112	122	92	33	40
Extremes	105-115	115-125	89-97	31-36	38-42
Standard deviation	2.9	2.9	3.1	1.3	1.4
Sample size	12	12	11	13	9
Females					
Mean	104	114	88	31	38
Extremes	101-109	110-119	86-91	30-33	36-41
Standard deviation	2.9	2.9	1.8	1.1	2.0
Sample size	12	12	12	12	6

TABLE 5. SKULL MEASUREMENTS OF IMMATURE LYNXES (mm)

Yearling Males (13-24) months	Basal Length	Condylo-basal Length	Zygomatic Width	Canine Width	Maxillary Tooth Row
Mean	109	118	90	30	41
Range	104-114	113-124	83-94	30-34	38-42
Sample size	33	33	36	35	8
Yearling Females (13-24) months					
Mean	102	112	86	30	39
Range	96-106	107-116	81-90	28-33	38-39
Sample size	13	14	16	15	4
Male Kittens (8-9) months					
Mean	95	106	81	31	-
Range	94-97	105-107	80-85	30-31	-
Sample size	7	7	7	5	-
Female Kittens (6-9) months					
Mean	91	101	79	29	-
Range	87-98	97-107	76-80	27-30	-
Sample size	8	9	9	9	-

Condylo-basal length is the distance between the most posterior part of the occipital condyle and the anterior margin of the premaxilla.

Zygomatic width is the greatest distance between the outside borders of the zygomatic arches.

Canine width is the distance between the labial surface of the canines at the alveoli.

Maxillary tooth row is the distance from the anterior side of the canine at the alveolus to the posterior side of P^4 at the alveolus. (c.f. Saunders, 1961)

No precise comparison of standard measurements and weights with those reported for Newfoundland (Saunders, 1961) was possible, as yearlings were included in his sample. Measurements and weights seem to be roughly of the same magnitude. Measurements and weights from other regions of North America are listed in Table 3 for reasons of comparison. The samples are small but suggest little variation in size and weight over most of the range.

Male and female skulls differed slightly but significantly (basal length t=6.75 for 23 d.f. and zygomatic width t=3.7 for 22 d.f.). Male and female skull measurements were compared with similar measurements from Newfoundland (Saunders, 1961) and Alaska (Kurtén and Rausch, 1959). The results are listed in Table 6. The basal length in Alberta for males and females was significantly larger than in their Newfoundland counterparts. Alberta males had a larger basal length than Alaska males, but Alberta females did not differ significantly from Alaska females. Newfoundland males were not significantly different from Alaska males, but

TABLE 6. SKULL MEASUREMENTS (mm) OF ALBERTA LYNXES*
COMPARED WITH MEASUREMENTS FROM NEWFOUNDLAND (SAUNDERS, 1961)
AND ALASKA (KURTÉN AND RAUSCH, 1959)

Males	Alberta	Newfoundland	Difference	Alaska	Difference
Basal Length					
Mean	112	108	significant	109	significant
Standard deviation	2.9	4.01	t=3.06	2.5	t=2.44
Sample size	12	24		8	
Zygomatic Width					
Mean	92	94	not significant		
Standard deviation	3.1	3.22	t=1.72		
Sample size	11	24			
Canine Width					
Mean	33	35	significant		
Standard deviation	1.3	2.75	t=2.45		
Sample size	13	22			
Maxillary Tooth Row					
Mean	40	40	not significant		
Standard deviation	1.4	1.22	t=0		
Sample size	9	24			

* Including specimens from the Northwest Territories

TABLE 6. (cont.)

Females	Alberta	Newfoundland	Difference	Alaska	Difference
Basal Length					
Mean	104	101	significant	105.1	not significant
Standard deviation	2.9	2.48	t=2.23	4.8	t=0.75
Sample size	12	13		16	
Zygomatic Width					
Mean	88	89	not significant		
Standard deviation	1.8	1.89	t=1.35		
Sample size	12	13			
Canine Width					
Mean	31	32	significant		
Standard deviation	1.1	.99	t=2.48		
Sample size	12	15			
Maxillary Tooth Row					
Mean	38	37	not significant		
Standard deviation	2.0	.86	t=1.66		
Sample size	6	15			

the basal length of Newfoundland females was significantly smaller than Alaska females (Saunders, 1961). Kurtén and Rausch (1959) reported that no significant difference could be demonstrated between Alaska males and females. Alberta and Newfoundland males both have a significantly larger basal length than the respective females. It seems, therefore, that the Alaskan male sample is not representative. Kurtén and Rausch (1959) mentioned their limited material as a possible factor. It seems also possible that the sample may have contained yearlings, as no mention is made as to how the material was aged or whether it was aged at all. No significant difference could be established between the measurements of the zygomatic width of Alberta and Newfoundland samples of both sexes. The canine width is larger in Newfoundland animals. No difference was found in the maxillary tooth rows of animals in both areas.

It appears from the above measurements that Western Canadian lynxes differ at least slightly in skull dimensions from the Newfoundland lynxes, but it remains doubtful whether there is a significant difference from Alaska lynxes.

Ossification in the Long Bones of the Fore Limb

The long bones of the right front leg were collected from all specimens. In some cases only the humerus could be obtained. Radius and ulna were collected in addition to the humerus to find out the time and order of closure of the different distal and proximal epiphyses. This would give information on the attainment of physical maturity and add more criteria for ageing to those described by Saunders (1961), and thus would possibly provide greater certainty in grouping the various developmental stages.

Only material of known collection date was used. The material, representing ten months of the year, consisted of 39 sets of male and 23 sets of female long bones. Samples were distributed as follows: January 11 males and 6 females; February 4 males and 4 females; April 1 female; May 5 males; June 2 males; July 2 males; August 1 female; September 2 females; November 4 males and 3 females; December 11 males and 6 females.

The larger samples of the months December, January and February could be divided into three or four distinct groups on the basis of the different stages of ossification. The smaller samples from the remaining months were interpreted on the basis of these larger samples, as they obviously represented either preceding or succeeding stages of ossification. Successive stages showing an orderly sequence of ossification of the proximal and distal epiphyses could be recognized for all the long bones of the fore limb. To make comparison of the different stages throughout the year easier, and to test their distinctness the different recognizable stages of each long bone were assigned a value (c.f. Lewall and Cowan, 1963). A description of the different stages of each long bone and the assigned values are given in Table 7 (see also Fig. 2A-2F. All sets of long bones were examined and given a value on this basis. The total value for each set of long bones was then plotted against the month of collection (Fig. 3). The resulting graph illustrates quite clearly the lack of overlap between each group for each month. The distinctness of the developmental stages is to be expected in an animal with a well defined and relatively short birth season, such as the lynx, and there is thus little doubt that these stages represent age groups. The group having values from 0 to 4 represents the kittens (0-12 months old). The central group with values ranging from 4 to 10 represents

TABLE 7. RECOGNIZABLE STAGES OF OSSIFICATION AND THEIR ASSIGNED VALUES

	Description of stage	Index value
Humerus	The proximal epiphysis is unossified. The distal epiphysis is unossified.	0
	The proximal epiphysis is unossified. The distal epiphysis has ossified but a visible suture remains.	1
	The proximal epiphysis is unossified. The distal epiphysis is ossified and no suture, open or closed, is visible.	2
	The proximal epiphysis is beginning to ossify (it does not come off when boiled for two hours) but there is an open suture all around. The distal epiphysis is ossified.	3
	The proximal epiphysis has an open suture on the antero-medial side, lateral and posterior sides have ossified, but show recently closed sutures. The distal epiphysis is ossified.	4
	The proximal epiphysis has a small unossified gap on the antero-medial face. The distal epiphysis is ossified.	5
	Complete ossification	6

TABLE 7. (cont.)

	Description of stage	Index Value
Ulna	The proximal epiphysis is unossified. The distal epiphysis is unossified.	0
	The proximal epiphysis is partly ossified but an open gap is present on the olecranon. The distal epiphysis is unossified.	1
	The proximal epiphysis is ossified. The distal epiphysis is unossified.	2
	The proximal epiphysis is ossified. The distal epiphysis is beginning to ossify (open suture all around but it won't come off after having been boiled for 2 hours).	3
	The proximal epiphysis is ossified. The distal epiphysis is ossified but closed suture lines are visible.	4
	Complete ossification	5
Radius	The proximal epiphysis is unossified. The distal epiphysis is unossified.	0
	The proximal epiphysis is ossified. The distal epiphysis is unossified.	1

TABLE 7. (cont.)

Description of stage	Index Value
The proximal epiphysis is ossified. The distal epiphysis is beginning to ossify (open suture, but it does not come off when boiled for 2 hours).	2
The proximal epiphysis is ossified. The distal epiphysis is ossified but a closed suture line is visible.	3
Complete ossification and no traces of sutures.	4

MAJOR STAGES OF OSSIFICATION OF THE PROXIMAL AND DISTAL EPIPHYSES OF THE LONG BONES OF THE FORE LIMB

FIG. 2A — ALL EPIPHYSES ARE UNOSSIFIED. EPIPHYSEAL CARTILAGE IS INDICATED BY
TOTAL ASSIGNED INDEX VALUE: 0
APPROXIMATE DURATION OF STAGE: 0-9 MONTHS OF AGE.

FIG. 2B — THE DISTAL EPIPHYSIS OF THE HUMERUS AND THE PROXIMAL EPIPHYSIS OF THE RADIUS ARE OSSIFIED. THE PROXIMAL EPIPHYSIS OF THE ULNA IS PARTLY OSSIFIED BUT A SMALL AREA ON THE POSTERIOR OLECRANON REMAINS UNOSSIFIED.
CLOSED SUTURES ARE INDICATED AS ----
TOTAL ASSIGNED VALUE: 4
APPROXIMATE DURATION OF STAGE: 10-18 MONTHS OF AGE.

FIG. 2C — THE PROXIMAL EPIPHYSIS OF THE ULNA IS NOW ENTIRELY OSSIFIED BUT MAY STILL BE DETECTABLE.
TOTAL ASSIGNED VALUE: 5
APPROXIMATE DURATION OF STAGE: 19-21 MONTHS OF AGE.

FIG. 2D — THE PROXIMAL EPIPHYSIS OF THE HUMERUS HAS CLOSED ON ONE SIDE: DISTAL EPIPHYSES OF RADIUS AND ULNA BEGIN TO CLOSE.
TOTAL INDEX VALUE: 9
APPROXIMATE DURATION OF STAGE: 21-25 MONTHS OF AGE.

FIG. 2E — THE PROXIMAL EPIPHYSIS OF THE HUMERUS HAS A SMALL UNOSSIFIED AREA ON THE ANTERO-MEDIAL FACE; CLOSED SUTURE LINES ARE USUALLY VISIBLE. THE DISTAL EPIPHYSES OF RADIUS AND ULNA HAVE OSSIFIED BUT SUTURE LINES ARE VISIBLE.
TOTAL INDEX VALUE: 12
APPROXIMATE DURATION OF STAGE: 28-30 MONTHS OF AGE.

FIG. 2F — OSSIFICATION IS COMPLETE AND NO VISIBLE SUTURE LINES REMAIN.
TOTAL ASSIGNED VALUE: 15
COMPLETE OSSIFICATION IS PROBABLY ATTAINED AT ABOUT 32 MONTHS OF AGE.

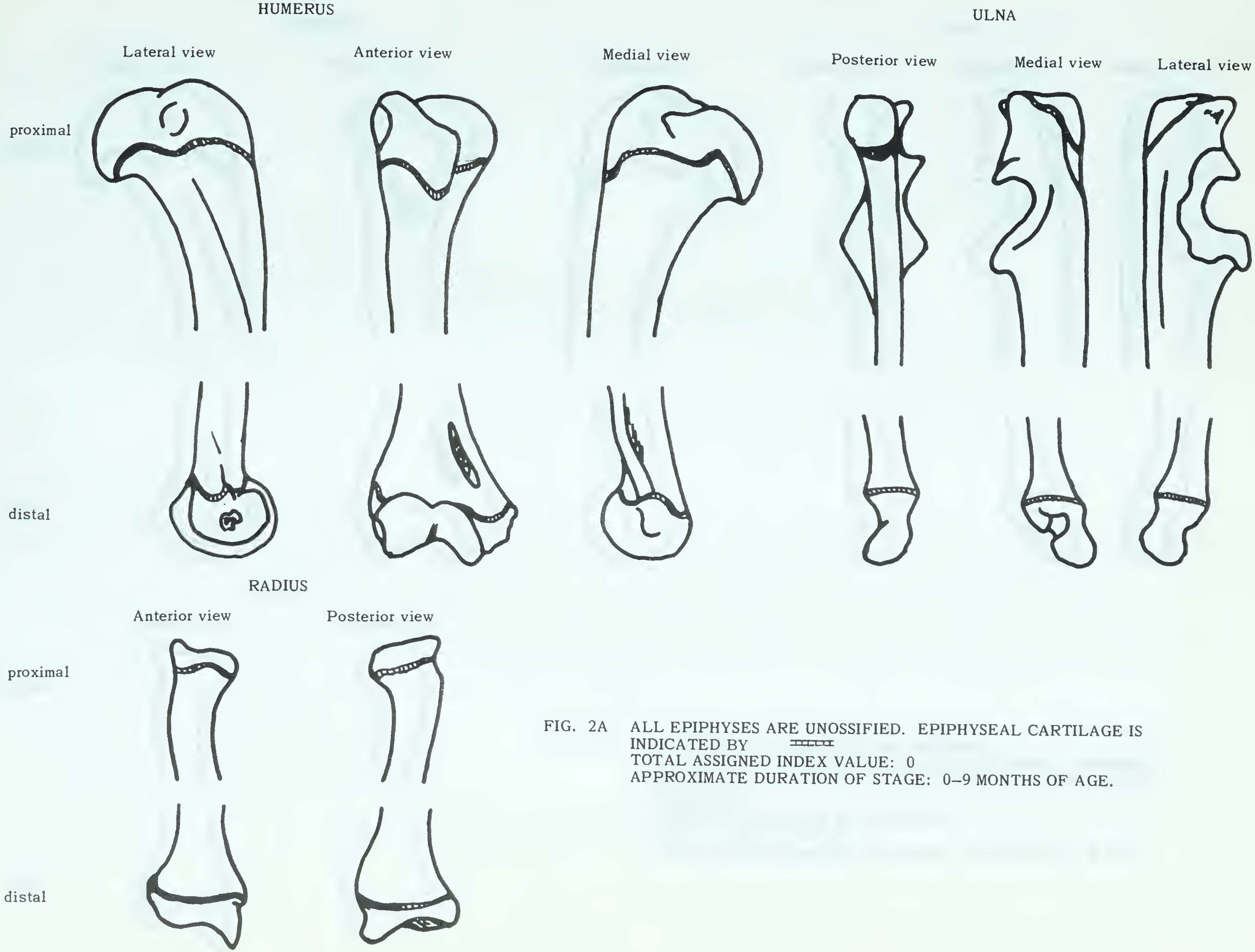


FIG. 2A ALL EPIPHYSES ARE UNOSSIFIED. EPIPHYSEAL CARTILAGE IS INDICATED BY
TOTAL ASSIGNED INDEX VALUE: 0
APPROXIMATE DURATION OF STAGE: 0–9 MONTHS OF AGE.

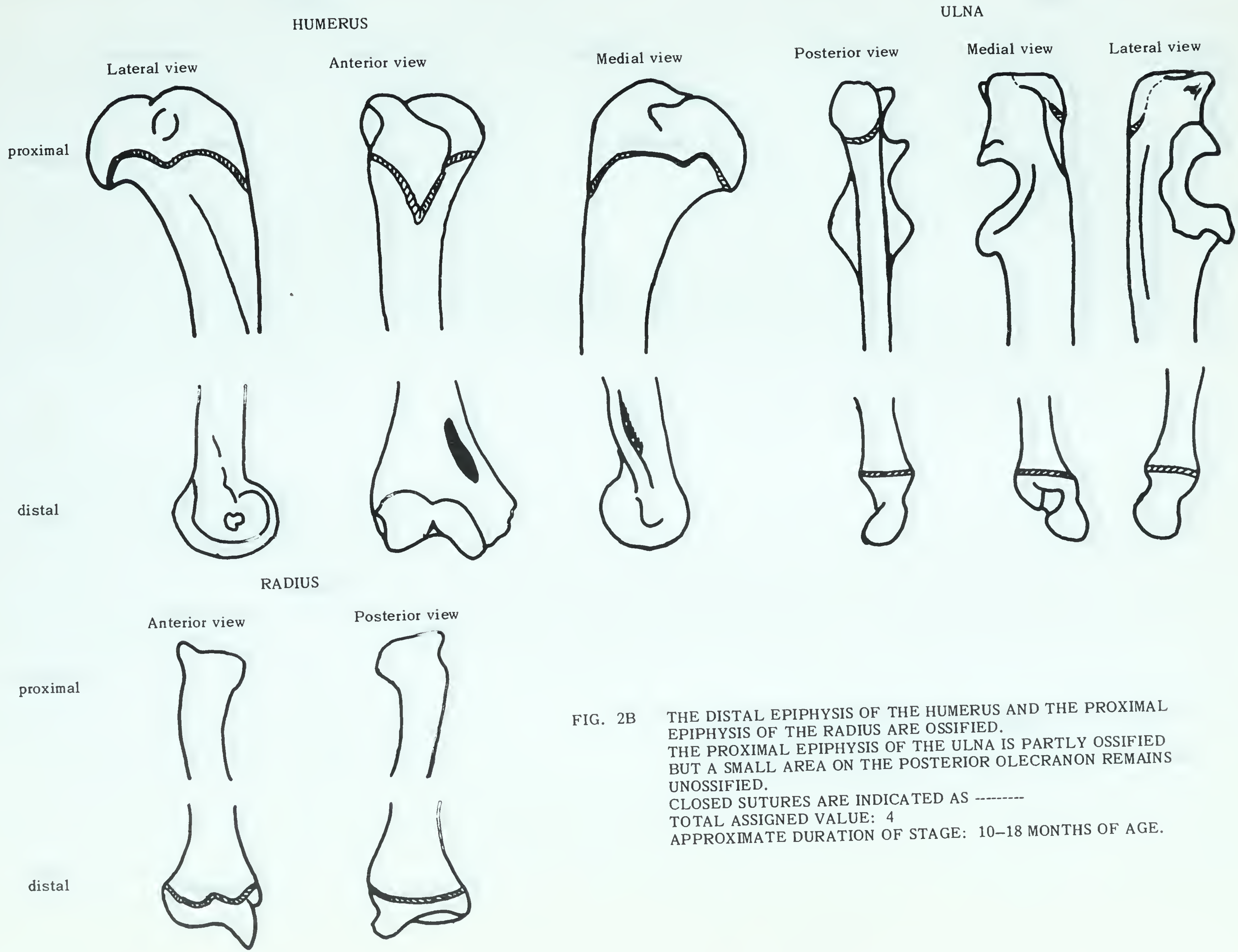


FIG. 2B THE DISTAL EPIPHYSIS OF THE HUMERUS AND THE PROXIMAL EPIPHYSIS OF THE RADIUS ARE OSSIFIED.
THE PROXIMAL EPIPHYSIS OF THE ULNA IS PARTLY OSSIFIED BUT A SMALL AREA ON THE POSTERIOR OLECRANON REMAINS UNOSSIFIED.
CLOSED SUTURES ARE INDICATED AS ---------
TOTAL ASSIGNED VALUE: 4
APPROXIMATE DURATION OF STAGE: 10–18 MONTHS OF AGE.

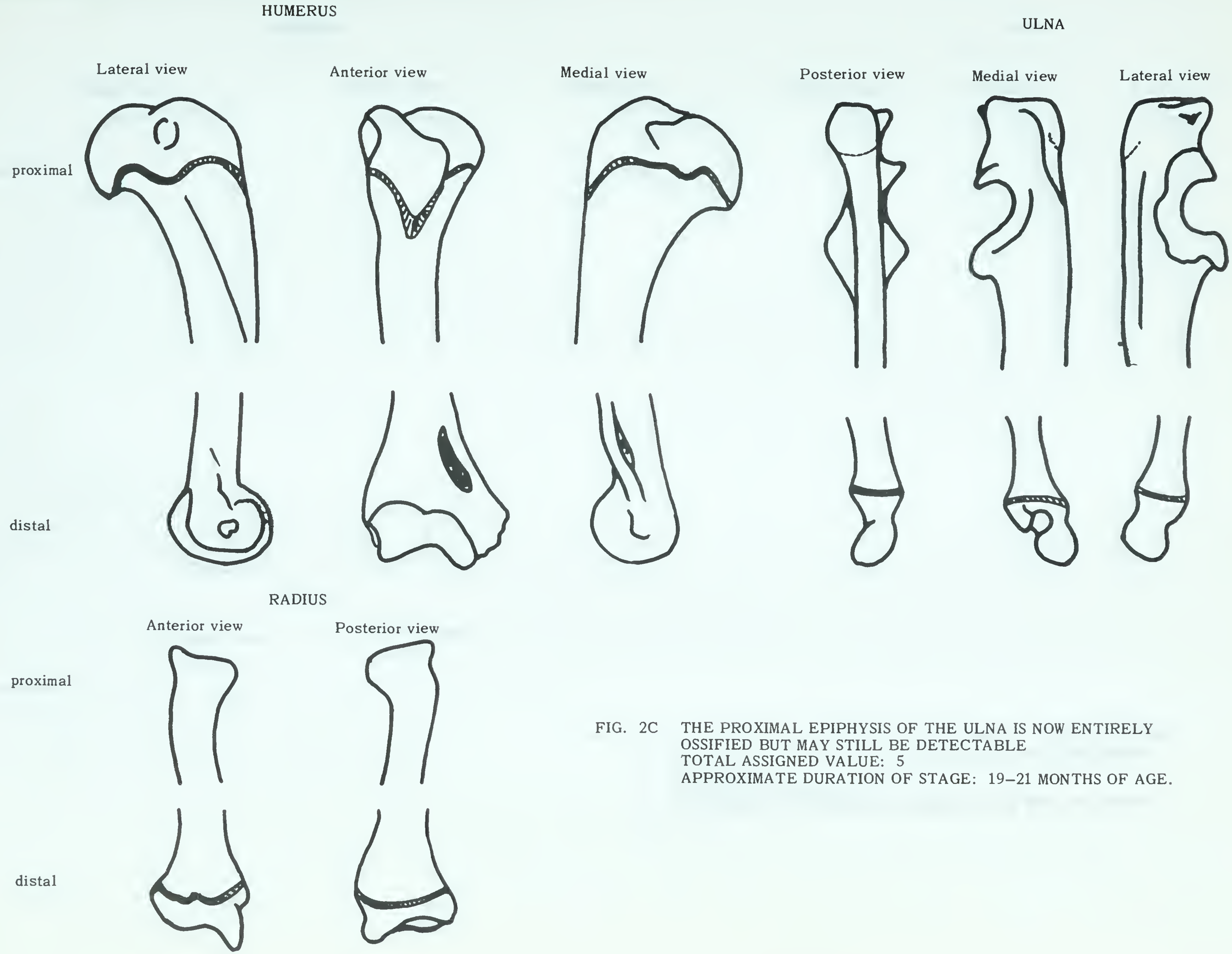


FIG. 2C THE PROXIMAL EPIPHYSIS OF THE ULNA IS NOW ENTIRELY OSSIFIED BUT MAY STILL BE DETECTABLE
TOTAL ASSIGNED VALUE: 5
APPROXIMATE DURATION OF STAGE: 19–21 MONTHS OF AGE.

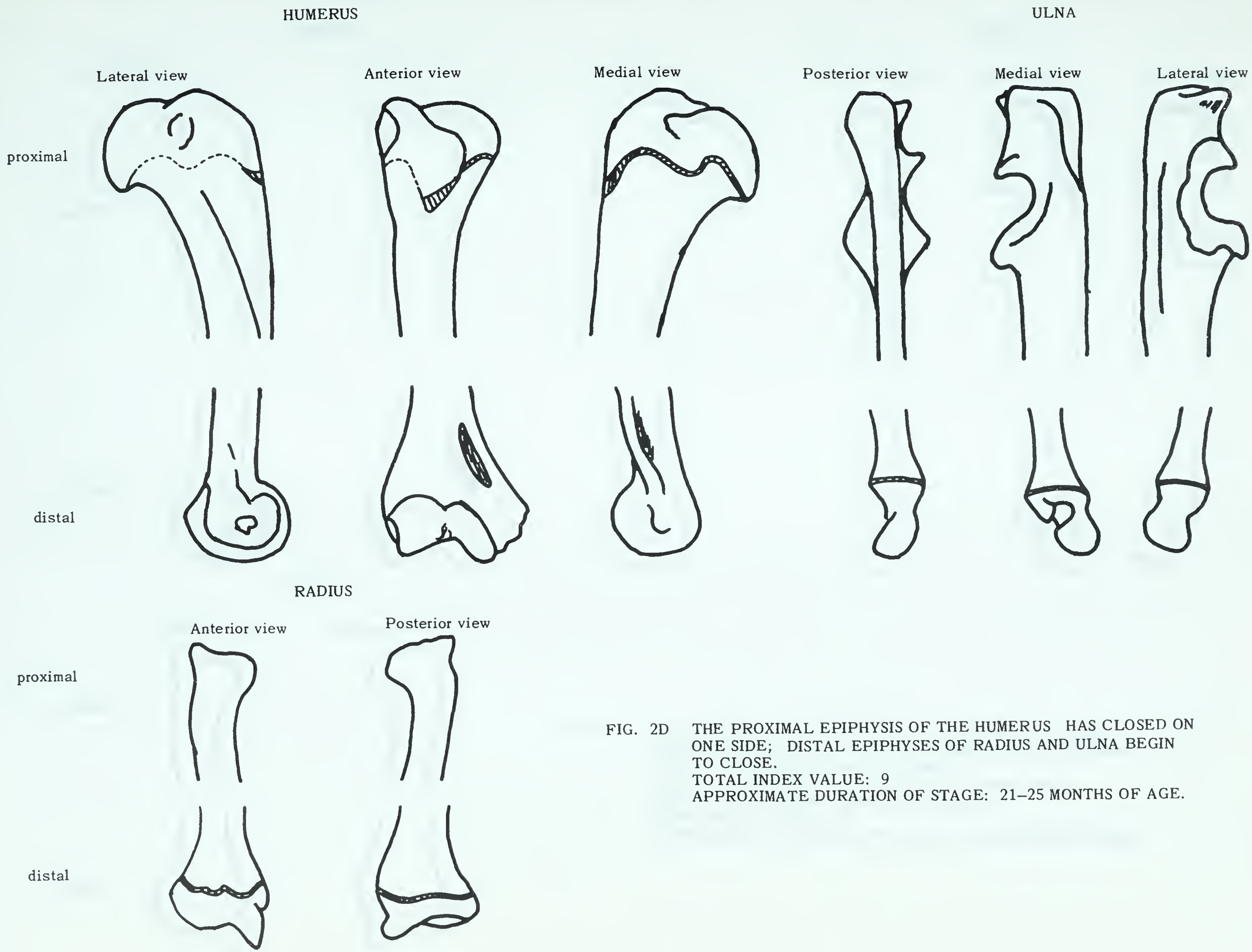


FIG. 2D THE PROXIMAL EPIPHYSIS OF THE HUMERUS HAS CLOSED ON ONE SIDE; DISTAL EPIPHYSES OF RADIUS AND ULNA BEGIN TO CLOSE.
TOTAL INDEX VALUE: 9
APPROXIMATE DURATION OF STAGE: 21–25 MONTHS OF AGE.

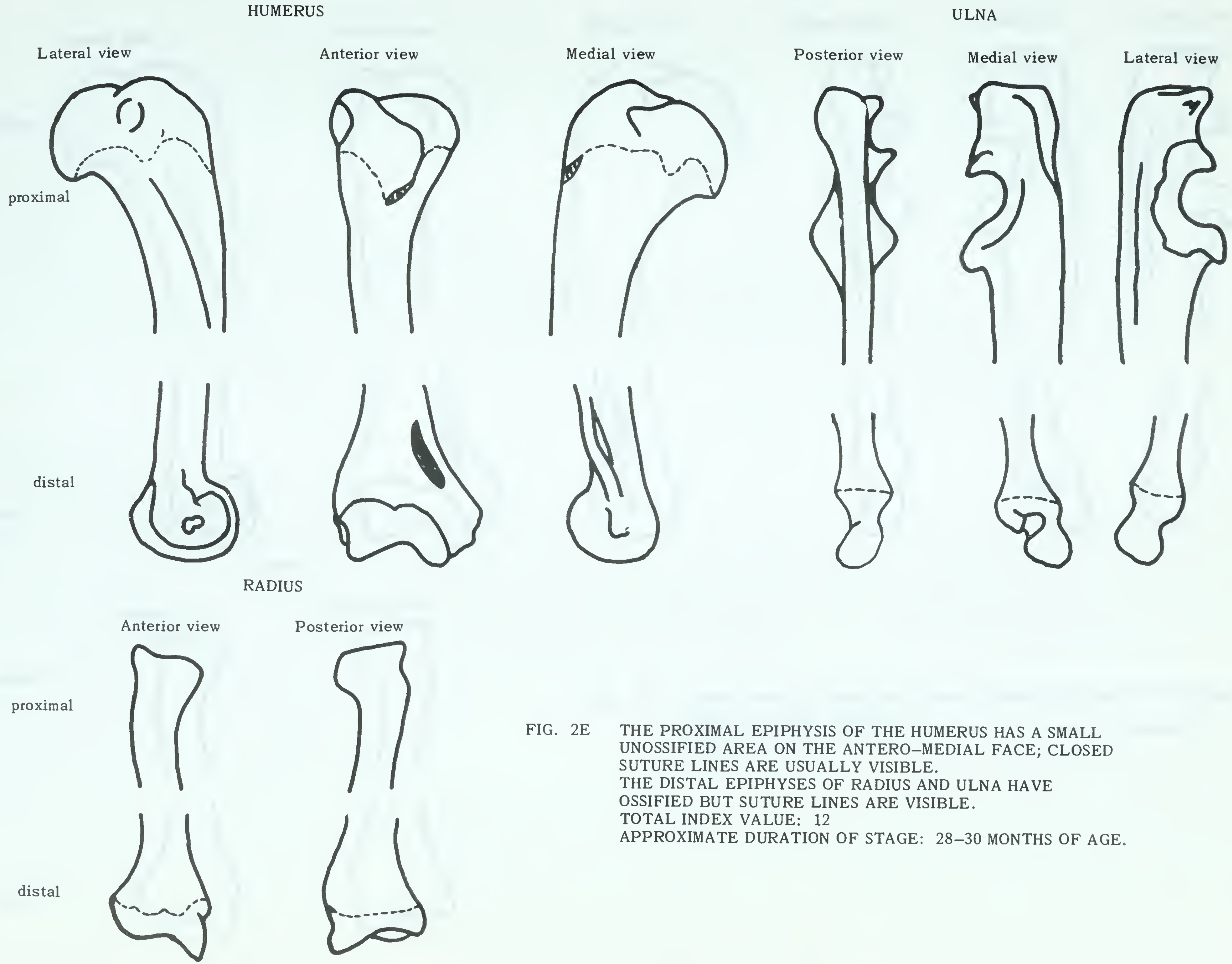


FIG. 2E THE PROXIMAL EPIPHYSIS OF THE HUMERUS HAS A SMALL UNOSSIFIED AREA ON THE ANTERO–MEDIAL FACE; CLOSED SUTURE LINES ARE USUALLY VISIBLE.
THE DISTAL EPIPHYSES OF RADIUS AND ULNA HAVE OSSIFIED BUT SUTURE LINES ARE VISIBLE.
TOTAL INDEX VALUE: 12
APPROXIMATE DURATION OF STAGE: 28–30 MONTHS OF AGE.

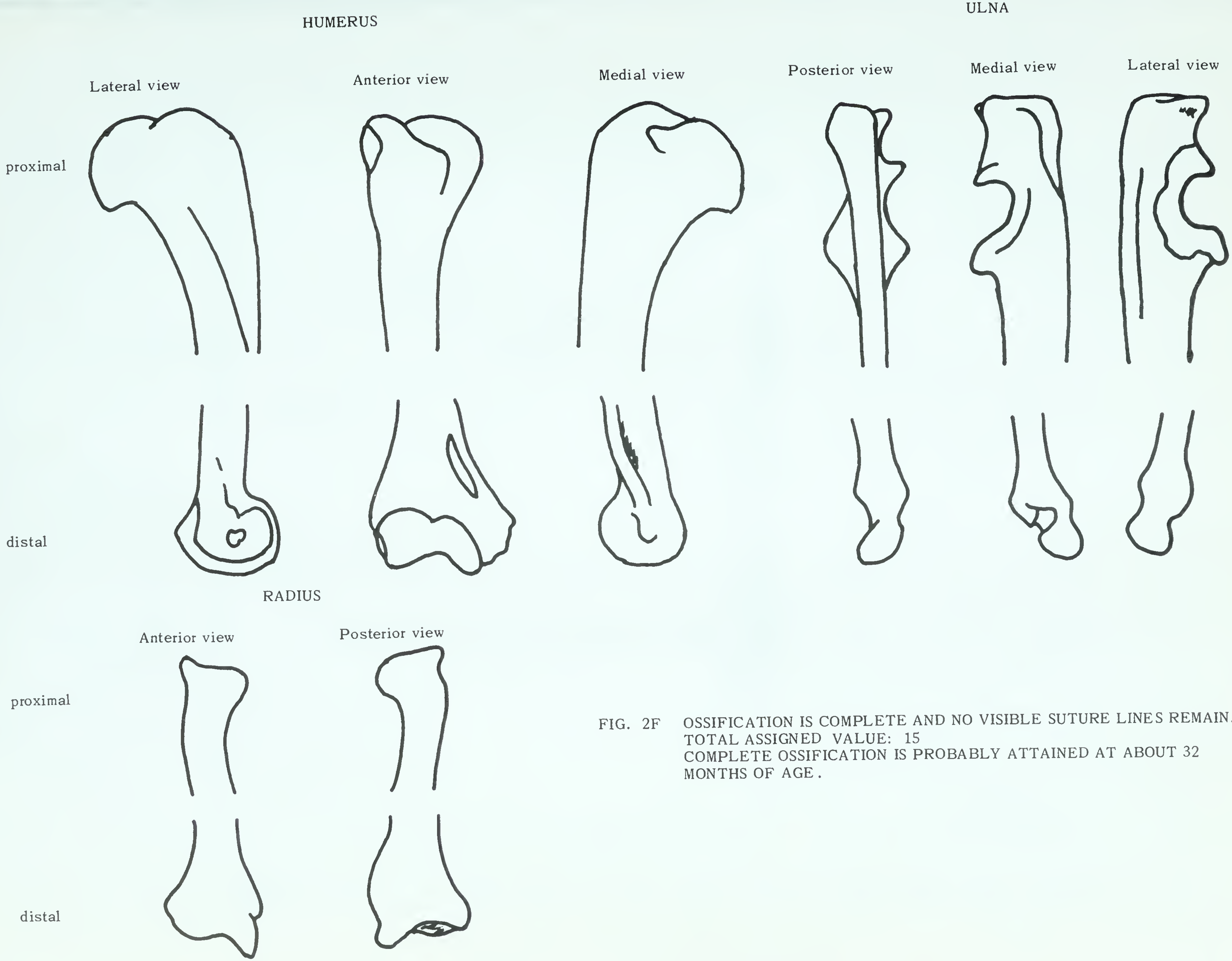
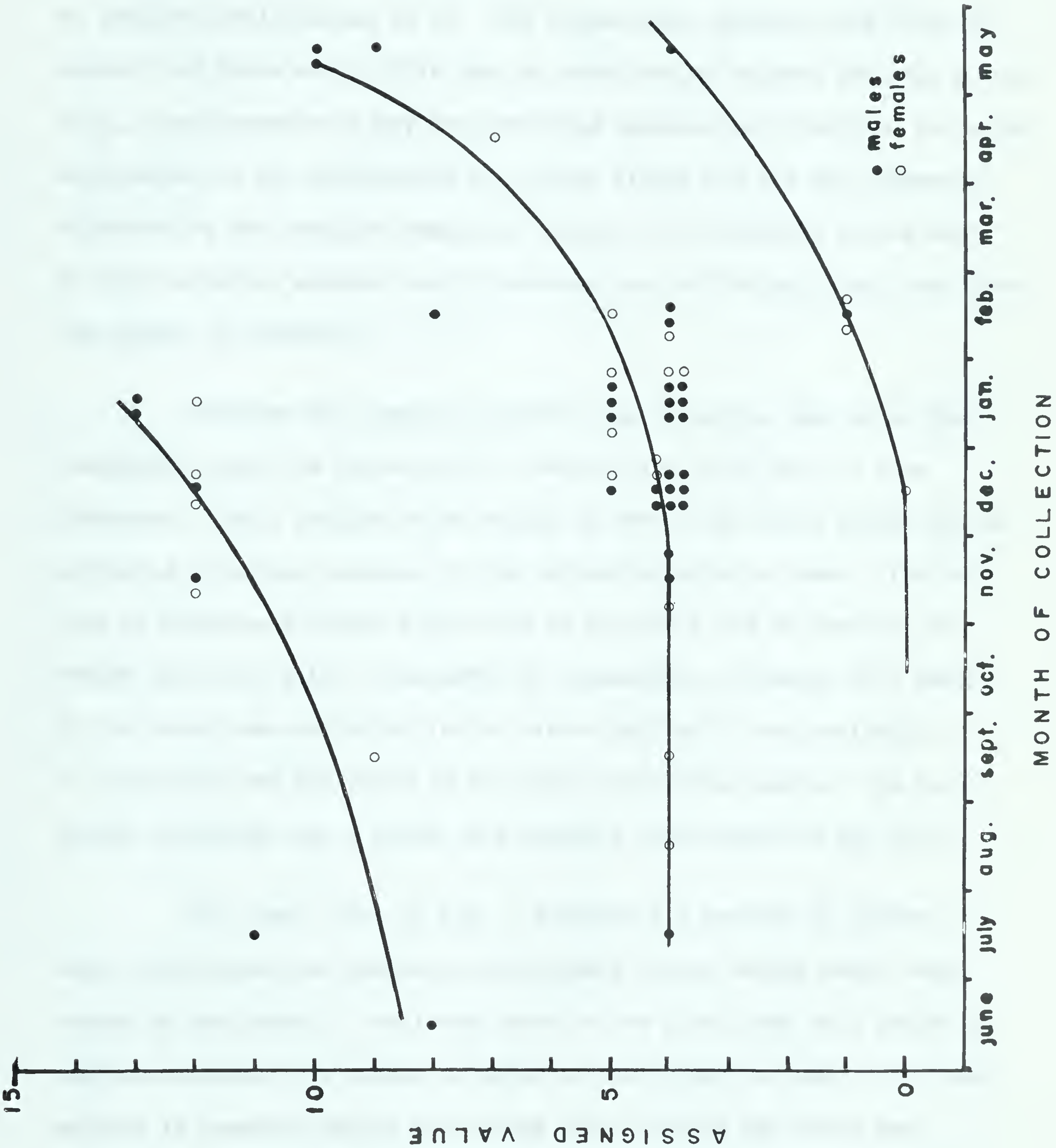


FIG. 2F OSSIFICATION IS COMPLETE AND NO VISIBLE SUTURE LINES REMAIN.
TOTAL ASSIGNED VALUE: 15
COMPLETE OSSIFICATION IS PROBABLY ATTAINED AT ABOUT 32 MONTHS OF AGE.

FIG. 3 INDEX VALUES FOR STAGES OF OSSIFICATION OF THE LONG BONES OF THE FORE LIMB PLOTTED AGAINST MONTH OF COLLECTION.



ASSIGNED VALUE
0
5
10
15
MONTH OF COLLECTION
june
july
aug.
sept.
oct.
nov.
dec.
jan.
feb.
mar.
apr.
may
● males
○ females

the yearlings (13-24 months old). The uppermost group with values from 8 to 13 represents 2-year-old animals. The total value obtainable at complete ossification is 15. The 2-year-olds approach this limit in January and there may at this time be some overlap between this age group (i.e., some 2-year-olds may have attained complete ossification) and older age groups, as the differences are rather slight and are not adequately expressed by the assigned numerical value. It is doubtful on the basis of this material, whether the 2-year-olds can be distinguished from older age groups in February.

Assuming the season of birth to be about the same as in Newfoundland, i.e., the latter half of May and the first half of June (Saunders, 1961), the age of an animal in any of the above groups can be estimated with some accuracy if the collection date is known. This was done by assuming a common birth date to be June 1 and by counting the months from this date to the month of collection, including this month if the animal was collected in the latter half of it and excluding it if the animal was collected in the first half of the month. The birth season extending over a month, the possible error would be ±15 days.

The trend lines in Fig. 3 indicate the periods of closure where they ascend and periods of relatively little change where their course is horizontal. The latter part of the first year is a period of closure preceded by a period in which all epiphyses are open. The same pattern is repeated during the second year, whereas the third year shows a steady trend towards complete ossification. The sequence of closure of the epiphyses was investigated and is briefly described below (see also Fig. 2A-2F and Table 8). Comparison of male and female material suggested great similarity in the rate of ossification, they are

TABLE 8. THE SEQUENCE OF OSSIFICATION IN THE LONG BONES OF THE FORE LIMB OF REPRESENTATIVE INDIVIDUALS

MALES

Collection date	Est. age	Humerus prox. epi.	Humerus dist. epi.	Ulna prox. epi.	Ulna dist. epi.	Radius prox. epi.	Radius dist. epi.
-V '63	11	O	●	◐	O	●	O
8 VII '63	13	O	●	◐	O	●	O
13 XI '61	17	O	●	◐	O	●	O
15 XII '61	18	O	●	◐	O	●	O
10 I '62	19	O	●	●+	O	●	O
1 II '62	20	O	●	●+	O	●	O
16 II '62	21	O	●	●+	O	●	O
1 VI '62	24	⊙	●	●	⊙	●	⊙
19 VII '62	26	◐	●	●	●+	●	●+
1 XI '62	29	●+	●	●	●+	●	●+
10 I '62	31	●+	●	●	●	●	●+

FEMALES

Collection date	Est. age	Humerus prox. epi.	Humerus dist. epi.	Ulna prox. epi.	Ulna dist. epi.	Radius prox. epi.	Radius dist. epi.
5 XII '61	6	O	O	O	O	O	O
7 II '62	8	O	⊙	O	O	O	O
12 VIII '62	14	O	●	◐	O	●	O
23 IX '62	16	O	●	◐	O	●	O
6 XI '61	17	O	●	◐	O	●	O
10 XII '61	18	O	●	◐	O	●	O
5 I '62	19	O	●	◐	O	●	O
20 II '62	21	O	●	●+	O	●	O
12 IV '62	23	◐	●	●	O	●	O
2 IX '62	27	◐	●	●	⊙	●	⊙
- IX '62	29	●+	●	●	●+	●	●+
27 XII '62	31	●+	●	●	●	●	●

O - completely unossified
⊙ - beginning ossification but an open suture all around
◐ - ossified, but open on one side
● - complete ossification
\+ - remnants of sutures visible.

therefore treated jointly, but have been listed separately in Fig. 3 and Table 8 for reasons of comparison.

In an animal collected on December 5, all epiphyses were unossified and the animal was estimated to be 6 months old.

Three animals collected on February 7, had ossified distal epiphyses of the humerus. Recently closed sutures could be distinguished, and in one specimen the suture was still partly open. These animals were considered to be 8 months old.

In one animal collected in May the distal epiphysis of the humerus had completely ossified. The proximal epiphysis of the ulna had partly ossified but was open at the posterior face of the olecranon. The proximal epiphysis of the radius was completely ossified. This animal was estimated to be 11 months old.

An animal collected on July 8, showed essentially the same condition as the previous animal. Its age was estimated at 13 months.

Twenty-seven animals collected in August, September, November, December and in the first half of January and estimated to be 14, 16, 17, 18 and 19 months old were all similar to the two previous animals; the only change was the gradual ossification of the open suture at the posterior face of the olecranon.

Ten animals collected in the last half of January and in February and estimated to be 20 to 21 months old, showed complete ossification of the suture at the posterior face of the olecranon, but in some cases it was detectable as a shallow bump. One individual in this age group showed beginning ossification of the proximal epiphysis of the

humerus.

Four animals collected in April and May and estimated to be 23 and 24 months old showed partial ossification of the proximal epiphysis of the humerus and also closing of the distal epiphyses of the radius and ulna.

Specimens collected in July and September (26 and 27 months old) showed further ossification at these sites.

In two November specimens the ossification seemed nearly complete, but closed sutures could be distinguished at the proximal epiphysis of the humerus and the distal epiphyses of the radius and ulna. In the humerus a small unossified gap remained, which persists in at least some animals, as it is recognizable in some December and January specimens, which would be approximately 31 months old.

The ossification of the long bones of the hind leg was not investigated, but in one January specimen estimated at 31 months old the long bones of the hind leg had completely ossified, although a closed suture line was visible at the distal end of the femur and the proximal end of the tibia.

Résumé and Discussion

The distal epiphysis of the humerus, and the proximal epiphysis of the radius and ulna closed in the second half of the first year of life. The proximal epiphysis of the humerus, and the distal epiphysis of the radius and ulna closed at the end of the second year. Complete ossification is attained in the third year. In other words, growth terminates at the elbow joint before it terminates at the extremities of the

limb. Indications are that the reverse is true for the long bones of the hind limb.

The growth in length of the humerus probably terminated before the final stage of ossification. Humeri of 23 and 24-month-old animals did not lose their proximal epiphyses when boiled for two hours; the final ossification of the epiphyseal cartilage therefore appears to proceed from the center. All growth in length stops when epiphysis and diaphysis become united at this time (approximately 24 months). The length of the humerus* plotted against the estimated age (Fig. 4) appears to show this. A growth curve fitted free hand does suggest a leveling off at about 24 months.

The results obtained in this study agree on the whole with those of Saunders (1961). No evidence was found in the present study that growth in males continues for a longer period than in females as Saunders suggested on the basis of his material. The difference in size between the sexes appears to be due to a faster growth rate of the males rather than a longer period of growth.

The skulls were examined and they showed changes parallel to the ossification of the long bones. These changes corresponded to the detailed descriptions and illustrations in Saunders (1961).

In kittens the temporal ridges form a broad U; they do not meet to form a sagittal crest. The lambdoidal ridge is not developed in young kittens, but appears in the latter half of their first year.

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* Measured from the greater tuberosity to the internal condyle.

FIG. 4 HUMERUS LENGTH PLOTTED AGAINST ESTIMATED AGE.

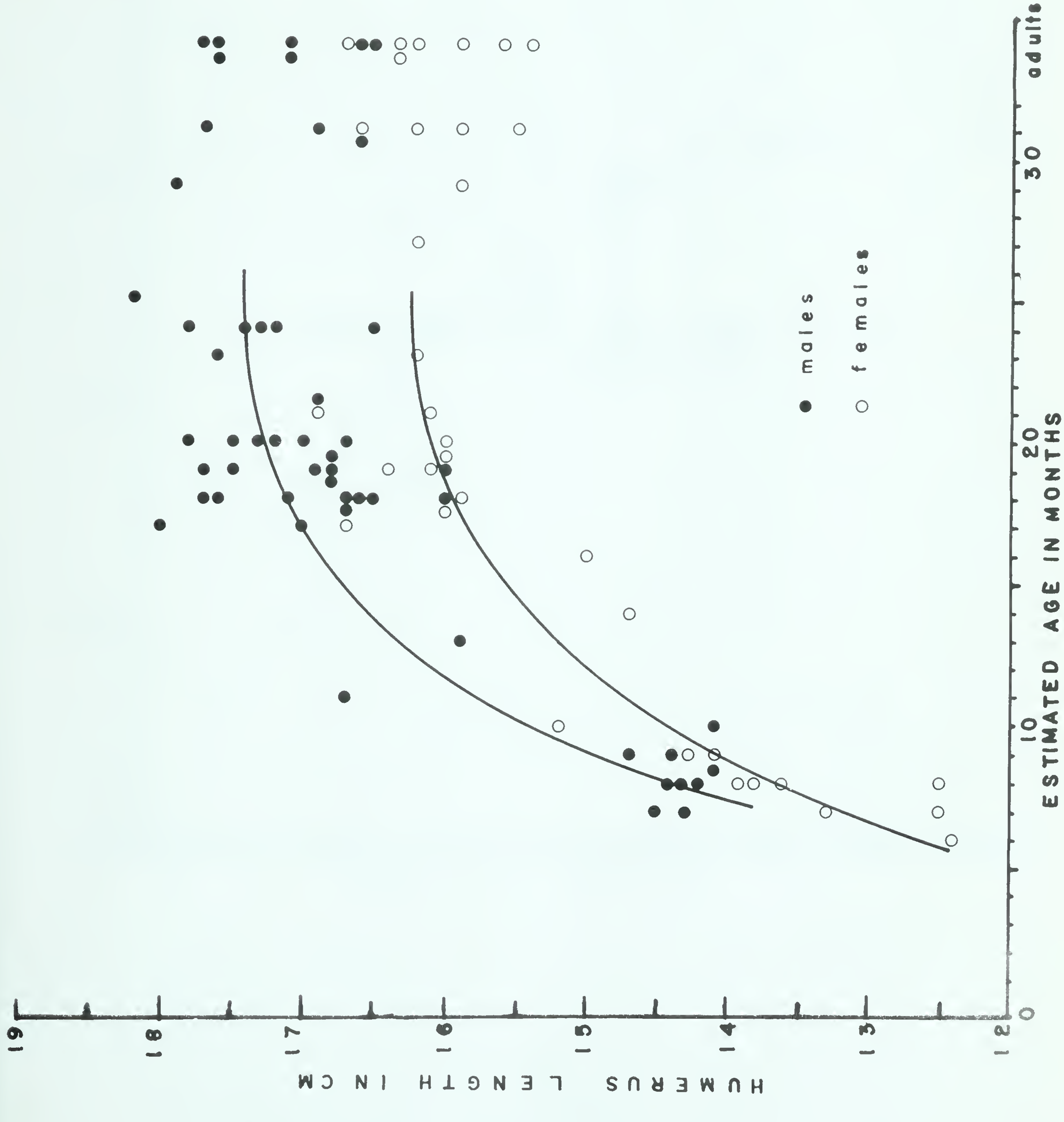
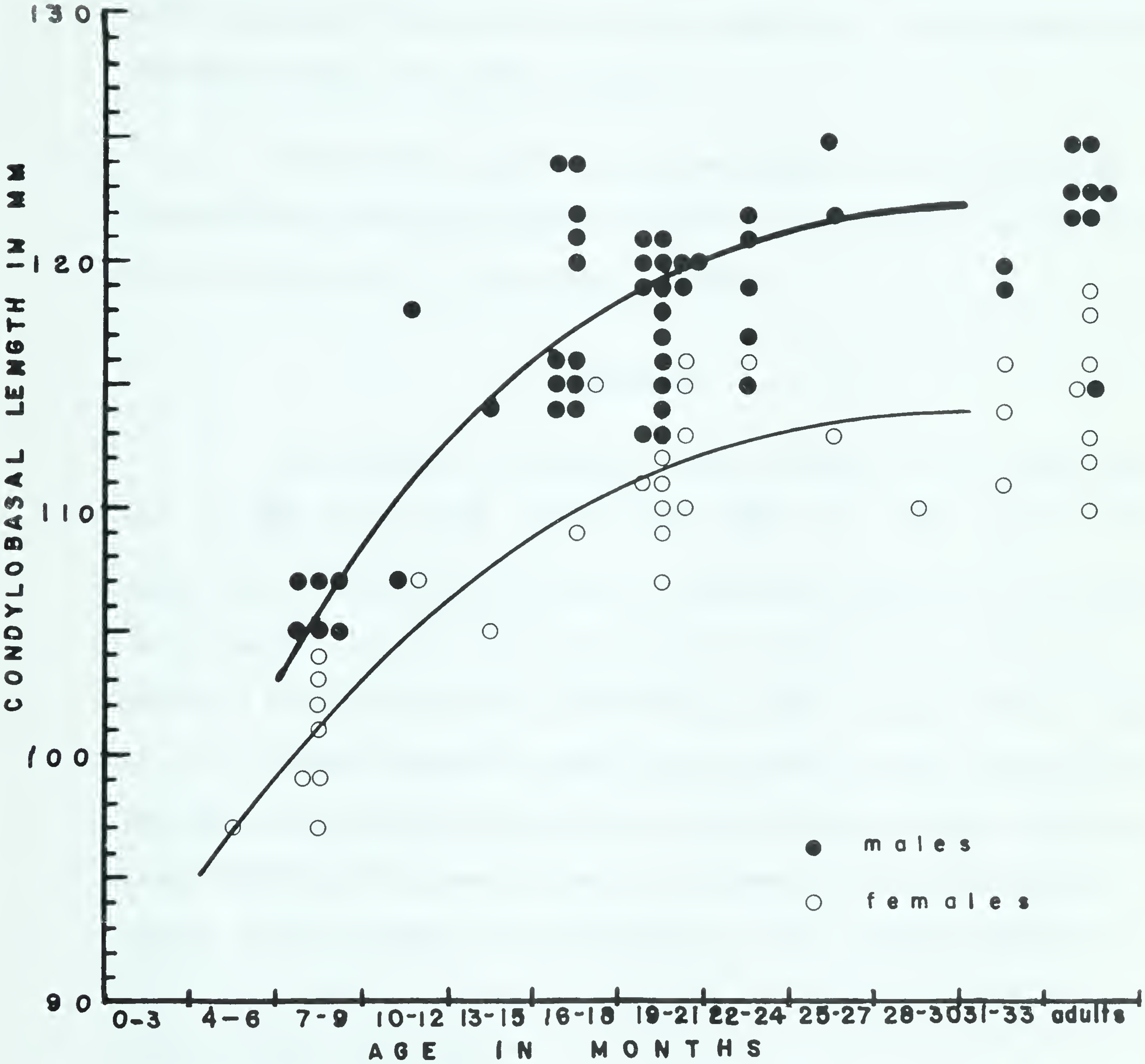
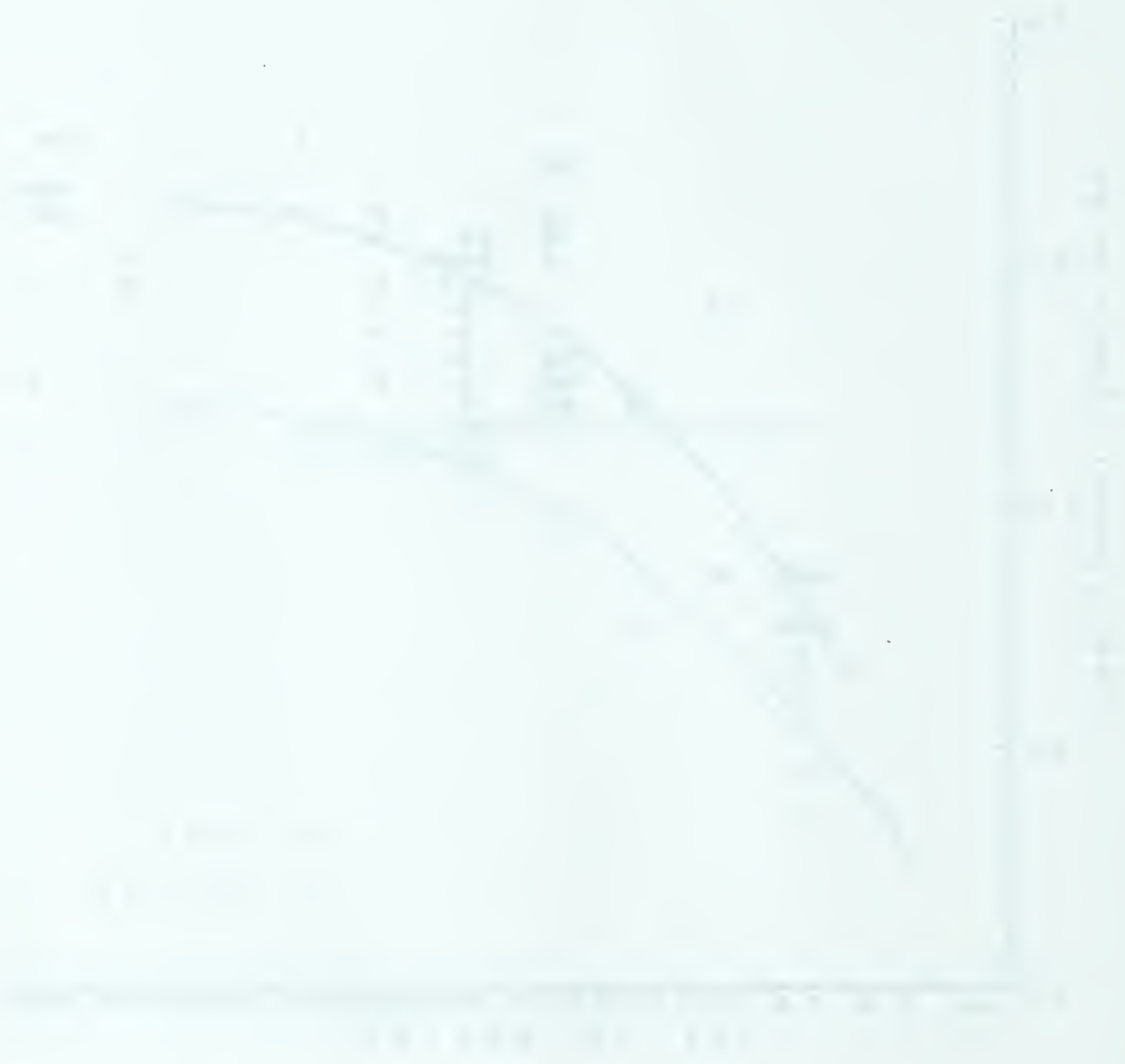

HUMERUS LENGTH IN CM
12
13
14
15
16
17
18
19
ESTIMATED AGE IN MONTHS
0
10
20
30
adults
males
females

FIG. 5 CONDYLO-BASAL LENGTH PLOTTED AGAINST ESTIMATED AGE.


130
120
110
100
90
CONDYLOBASAL LENGTH IN MM
0-3
4-6
7-9
10-12
13-15
16-18
19-21
22-24
25-27
28-30
31-33
adults
AGE IN MONTHS
males
females



In yearlings the temporal ridges narrow and join posteriorly to form a sagittal crest. The lambdoidal ridge develops further and attains adult proportions towards the end of the second year. Adults have distinct lambdoidal ridges and sagittal crests.

Condylo-basal length was plotted against estimated age (Fig. 5). The resulting scattergram seems to suggest a leveling off at about 24 months as was demonstrated for the humerus in Fig. 4.

Dentition

The deciduous and permanent dental formulas of the Canada lynx are: dI $\frac{123}{123}$ dC $\frac{1}{1}$ dP $\frac{34}{34}$ X 2 = 24 and I $\frac{123}{123}$ C $\frac{1}{1}$ p $\frac{34}{34}$ M $\frac{1}{1}$ X 2 = 28. Seton (1910) stated that there are two additional premolars in the upper jaw in youth. The P^2 is said to be usually present in the kitten, but rarely in the adult Eurasian lynx (Gaffrey, 1961; Novikov, 1956). None of the 19 kittens examined in this study had more than two upper deciduous premolars, these findings agree with those of Saunders (1961). Manville (1963) found the P^2 present in only 2 of a sample of 465 Canada lynx skulls, in one of these it was unilateral. These findings suggest that Seton was in error, although the situation in the Eurasian species is still in doubt (see below).

The skulls of kittensof known collection dates, and 3 kittens of known age, were examined for tooth eruption and replacement. The kittens of known age were 17, 27 and 36 days old. At 17 days of age the dC $\frac{1}{1}$ were on the verge of erupting, but they were still covered by the gums. In the 27-day-old animal, dI $\frac{123}{123}$ and dC $\frac{1}{1}$ had erupted. In the 36-day-old specimen dP $\frac{34}{34}$ had fully erupted.

In the skull of a female kitten collected on December 5 (6 months old) I $\frac{123}{123}$ dC $\frac{1}{1}$ dP $\frac{34}{34}$ and M $\frac{1}{1}$ were present; I^3 had not completely erupted. C $\frac{1}{1}$ and P^4 were visible under their deciduous counterparts.

In another kitten, estimated to be 7 months old, all incisors, canines, P^4 and M $\frac{1}{1}$ were fully erupted; dP $\frac{3}{34}$ were still present, although their permanent replacements had started to emerge.

Most 8 to 9-month-old animals had a full set of permanent teeth, but dP_3 was present in some cases and P_3 and sometimes P_4 had not fully erupted.

The teeth of two animals ages 13 and 14 months (collected on July 8 and August 12) were examined. The roots of all teeth had closed in the 13-month-old individual, while a small opening to the root canal still remained visible in the upper canine of the 14-month-old individual.

The results of the foregoing investigation have been tabulated in Table 9 to provide a tentative outline of tooth eruption and replacement. Data from Saunders (1961) are incorporated in the table for completeness.

Tooth wear was investigated on adult skulls. Wear was most noticeable on the shearing planes of the upper and lower carnassial (lingual side of the P^4 and buccal side of the M_1). The worn area was larger in adults than in yearlings, but it does not seem to be feasible to use it as a means of ageing adult lynxes at present.

The posterior root of P^4 of an 18-month-old lynx, a 31-month-old lynx and an adult of unknown age were sectioned with a dental saw at .006 inch to investigate whether annuli were present in the cementum layer.

TABLE 9. TOOTH ERUPTION AND REPLACEMENT

Date	Estimated Age	I	C	P	M	
June 25	17 days		(a) (a)			
June 25	27 days	a a a a a a	a a			
July 3	36 days	a a a a a a	a a	a a a a		
July 29	2 months	a a a a a a	a a	a a a a		Saunders, 1961
September	4 months	A A a A A a	a a	a a a a	A A	"
December 5	6 months	A A A A A A	a (A) a (A)	a a(A) a a	A A	
December	7 months	A A A A A A	A A	a (A)A a a (A)(A)	A A	
January & February	8-9 months	A A A A A A	A A	A A a A (A)	A A	
July 8	13 months	all roots have closed				
August 12	14 months	a small opening remained in the upper canines.				

a = deciduous tooth

A = permanent tooth

( ) = erupting or on the verge of erupting

A = crowns formed but not erupted.

The sections were dehydrated in absolute alcohol, cleared in xylene and mounted in Canada balsam. Examination was by transmitted and reflected light. The cementum layer showed an increase in thickness with age, but no distinct annuli could be seen.

Discussion

There seem to have been no previous studies of the eruption and replacement of teeth in the Canada lynx, but Lindemann (1955) published the following data on milk dentition of the European species (teeth are listed in order of appearance):

"Eruption of the canines at	14-17 days of age
Eruption of the incisors at	17-20 days of age
Eruption of dP^2 (lacking in permanent dentition) at	24-25 days of age
Eruption of dP^3, dP_3, dP_4 at	27-30 days of age
Complete development at	90 days of age
Beginning of replacement by permanent teeth at	140 days of age."

These results are difficult to interpret because of the uncertainty regarding the true occurrence of dP^2 in the European lynx. Did Lindemann mistakenly refer to the deciduous upper premolars as dP^2 and dP^3, or did he somehow manage to overlook dP^4? In spite of this difficulty, there is good correspondence between Lindemann's results and those shown in Table 9.

There have been no previous attempts to correlate wear on the permanent teeth or cemental annuli with age.

Molt

The following results are based on examination of 11 pelts representing 7 months of the year, and on daily observations of 5 captive lynxes for the period September 1962 to August 1963. Pelts examined for April (1), May (1), June (1), July (3), August (1) and September 2nd (1) were all unprime, showing dark areas indicating that hair growth was taking place. No October pelts were available but 3 November pelts were prime (November 13, 16 and 17).

The first loss of hair in the captive lynxes was observed on March 21. Molting became quite evident in April and appeared to have started on the head, neck and shoulders spreading posteriorly and ventrally. Both wool hair and guard hair were shed, but the shedding of guard hair seemed to be more complete. One individual in particular showed patches in which all guard hairs were shed and only underfur was present. The molt was gradual; hair was lost continually in decreasing quantities well into early summer (at least to the end of June and the beginning of July), and new hair was growing in at the same time. The attainment of the winter coat appeared to be due to continued growth of hair into the fall. The time at which primeness was reached, was hard to determine with any accuracy, but it must have occurred somewhere between the middle of September and the end of October. The only changes occurring in the winter seem to be a gradual bleaching of the guard hair towards late winter.

Saunders (1961) reported the first signs of molt, unprime spots on the hind leg of one pelt on March 25, and said that winter pelage had developed in all October and November pelts in Newfoundland.

FOOD HABITS

The stomach and gut contents of 75 animals were saved in separate containers in 10 percent formalin for analysis of food habits. The material represents the period from November 1961 to May 1963.

The gut contents were later pulverized and washed to clean out most superfluous faecal matter; hair, feathers and all hard parts such as teeth, bone fragments and claws were savedfor identification. Stomach contents usually presented little difficulty as prey species could usually be readily identified. Hairs were identified by comparison with whole mounts of known hairs, and impressions of their cuticular scale patterns with those of known hairs. The hairs were cleaned in carbon tetrachloride if necessary. Two or more hairs were then put on a cellulose acetate slide of the type normally used to make fish scale impressions. They were arranged in such a way that the base of some and the tips of others extended over the edge of the slide. A moderate amount of acetone was then lightly applied with the tip of a feather. The acetone dissolved the surface of the slide, causing the hairs to sink in. After a few seconds to allow the acetone to evaporate, the hairs were pulled off leaving a clear mold of the cuticular scales. Considerable variation exists in the cuticular scale pattern from the base to the tip of the hair. Comparison of all regions of the hair were made to arrive at a correct identification. Teeth, skeletal material, claws, feet, bills, etc., were identified by direct comparison with specimens in the collection of the Department of Zoology, University of Alberta.

Stomach and gut samples from each individual were treated as one, because in the majority of cases they seemed to represent one meal. The results are expressed in Table 10. The small sample size made a breakdown into separate regions and seasons undesirable. The seasonal breakdown was limited to winter and summer, on the assumption that snowcover presents the most important ecological factor determining the availability of food (Formosov, 1946). The area covered by the survey is vast and variations exist as to first appearance and duration of snowcover. The divisions were therefore arbitrarily based on conditions in the central part of the area (Edmonton). The winter period extends from November to March (5 months); the summer period from April to October (7 months).

Not much is known about the relative abundance of the prey species during the period of investigation. Snowshoe hare (Lepus americanus) populations showed first signs of decrease, at least locally, in the summer of 1961 (Keith, oral communication), but hares were still plentiful during the winter of 1961-1962 and the following summer. The main decline seems to have occurred in central Alberta during the winter of 1962-1963, but was probably a year earlier in the Northwest Territories. In the spring of 1963 the hares were definitely "down" everywhere, according to most informants. Microtines, grouse and red squirrels (Tamiasciurus hudsonicus) were considered to be relatively abundant during 1961 and 1962.

Mammals were the most important food in summer as well as winter. Five genera of mammals were found in the winter sample. The snowshoe hare was most frequently eaten, followed by Microtus. All the Microtus were recorded from the months of November and December, suggesting a decrease in availability with the increased depth and permanence of snowcover. Red squirrel and beaver (Castor canadensis) occurred once. Deer (Odocoileus sp.) was found on three occasions. It is impossible to say

TABLE 10. ANALYSIS OF 75 DIGESTIVE TRACTS FROM THE LYNX

	Winter n=52		Summer n=23	
	Frequency occurrence	% occurrence	Frequency occurrence	% occurrence
Snowshoe hare	41	79	12	52
Microtus	5	10	5	22
Clethrionomys	-	-	2	9
Red Squirrel	1	2	2	9
Richardson ground squirrel	-	-	1	4
Columbian ground squirrel	-	-	1	4
Beaver	1	2	-	-
Deer	3	6	-	-
Total Mammals	45	86%	20	87%
Grouse	5	10	1	4
Gray Partridge	-	-	1	4
Duck	-	-	2	9
Unidentified bird	7	13	4	17
Total Birds	12	23%	8	35%
Grass	5	10	5	22

whether it was carrion or killed by the lynx itself. There is little doubt that a full grown lynx can successfully attack and kill, at least a small deer, particularly when favored by snow conditions.* Saunders (1963 b) reported an unsuccessful attack on a female caribou (Rangifer tarandus) and a number of alleged lynx kills of the same species. Sheppard (1960) reported a small mule deer (Odocoileus hemionus) killed by a lynx. Seton (1910) also reported deer killed by the lynx.

Birds are the second most important group after the mammals. Grouse were most frequently eaten. In two cases the grouse could be identified with certainty as Ruffed Grouse (Bonasa umbellus). The other grouse remains probably belonged to the same species, but this could not be established with certainty. In all cases the grouse remains were associated with buds and catkins of deciduous trees or shrubs.

The birds listed as unidentified could not be determined because only a few feathers or fragments of feathers were found. Judging from the diameter of the shafts, they all appeared to be medium sized birds (the size of a crow or chicken). It is possible that some of the bird remains in this category originated from the bird wings frequently

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* The weight-load, calculated for two winter animals, was 38 and 34 g/cm^2 of foot surface area. Similar figures for the Eurasian species (all taken from Yurgenson, 1955) are: 42 g/cm^2 (Pechora basin, Teplov); 40-60 g/cm^2 (Altai, Dulkeit); 34-39 g/cm^2 (Moscow region, Formosov). These figures may suggest better adaption to snow conditions in the New World species. In this respect it should be noted that the measurements of the hind foot are greater in the Canada lynx than in the Eurasian species, although the latter is a much larger animal. Mean hind foot length for the Canada lynx is about 23 cm; the range in the European lynx is 19-22.5 cm.

used as lures by trappers in this area.

The summer food habits showed a greater variety of prey species and decreased dependence on snowshoe hare. Microtines are more available during this season, and were found most frequently after snowshoe hare. Red squirrels were found twice, a rather low frequency if the relative abundance of this species is taken into consideration. Its quickness and alertness, as well as its partly arboreal habits probably reduce its availability as a lynx food. Richardson's ground squirrel (*Citellus richardsoni*), a species of the open plains was found once. This ground squirrel reflects the invasion of unusual habitats by the lynx during periods of high population pressure. The specimen containing the ground squirrel was collected near Calgary. One lynx collected at Gorge Creek contained three Columbian ground squirrels (*Citellus columbianus*).

The importance of birds in the summer food habits was witnessed by a higher overall occurrence, as well as a greater variety of species. Grouse had decreased in importance compared with the winter. Remains of a Gray Partridge (*Perdix perdix*) were found in an animal collected near Brooks. This also represents an unusual prey species. Two ducks were found, one of which could be identified as a Mallard (*Anas platyrhynchos*). The unidentified birds were represented by feathers or feather fragments, and in some cases bony parts and feet. In the majority of cases they seemed to have belonged to passerines.

Grass occurred in the digestive tract in winter and summer. The quantities eaten varied from two or three blades to a "handful" of grass. Captive lynxes were given fresh grass regularly during the summer. They apparently liked to eat it; different animals were observed on more

than one occasion to leave their feeding tray when fresh grass was made available. Domestic cats and dogs eat grass but it is not known what benefit they derive from it. Grass was also recorded by Saunders (1963 b).

Only a general comparison of the food habits of Western Canada lynxes with those of Newfoundland is possible (Saunders,1963 b), because the Newfoundland survey is based on a much larger sample collected over a five year period.

Nine mammals are listed as prey of the lynx in Newfoundland, but only four are of common occurrence; snowshoe hare occurred in 73 percent of the total sample; moose (*Alces alces*) in 15 percent; *Microtus* in 14 percent and caribou in 5 percent.

In the present study eight kinds (in some cases one 'kind' may include two species, e.g., deer) of mammals were found. The four most commonly occurring were: snowshoe hare in 71 percent of the total sample, *Microtus* in 13 percent, deer in 4 percent and red squirrel in 4 percent. In both areas the snowshoe hare is the most important food item in all seasons. The most striking difference is the frequency occurrence of moose in Newfoundland, where it represented the second most frequent food item in three out of four seasons (believed to be carrion in most cases). Saunders (1963 b) pointed out that sampling bias was probably responsible for this. *Microtus* is the second most frequently encountered species in the summer. Caribou, next in importance, occurs in three out of four seasons. It occupies a place of importance similar to that of deer in the present study, except that the latter has only been recorded in winter. Birds are about equally important in both areas; they occurred in 21 percent of the total sample in Newfoundland

and in 27 percent of the total sample in Alberta. The main difference is the fairly high occurrence of grouse * (in 8 percent of the total sample) and ducks (in 3 percent of the total sample) in Western Canada. The most frequently occurring bird of comparable size in Newfoundland was the ptarmigan (Lagopus sp.), which occurred in 2 percent of the total sample.

It appears that food availability, on which the success of the species chiefly depends is not appreciably different in the two areas. In the relatively varied fauna of the continent as well as in the impoverished fauna of Newfoundland, survival depends on a small number of species especially during the critical winter season.

Food specialization in the Felidae is related primarily to size. A medium sized cat such as the lynx depends mainly on medium sized prey. The small number of medium-sized prey species in the range of the Canada lynx explains the extreme dependence on the snowshoe hare. The lack of stability in lynx populations is closely linked with this dependence on one species. MacLulich (1937) demonstrated the existence of a correlation between numbers of snowshoe hare and lynx abundance. Yurgenson (1955) reported that the lynx numbers in the forests of the Central Zone of the USSR were relatively stable and fluctuated within narrow limits during a period of almost 20 years, (the high was 3 times the low). The fluctuations of the varying hare (Lepus timidus) during this period were of a much larger amplitude (the high was 12.5 times the low), and although they affected the lynx population in the area, the predator-prey relationship was not a simple one. Negative and positive relationships were observed. This seems to suggest dependence on a greater

* Grouse do not occur in Newfoundland.

variety of prey species. No food habit analysis was done in the area of study, but winter food analyses from other areas of the central zone of the USSR (Popov and Gavrin in Yurgenson, 1955) show a smaller proportion of hares and greater proportions of other prey species, than were found in North America. Small ungulates, such as roe deer (*Capreolus capreolus*) and musk deer (*Moschus* spp.) and the young of larger ungulates are important prey species in some areas, especially the mountainous regions of the USSR. I do not have any information on the stability of the lynx populations in these areas, but suspect them to be quite stable. Novikov (1956) said that sharp fluctuations occur in the Soviet Union regionally, apparently in response to fluctuations in hare populations.

PARASITES

Ectoparasites

Live lynxes (15) and lynxes that had recently died (3) were examined for the presence of ectoparasites with negative results.

One of two fleas was collected from a lynx shot at Gorge Creek by Mr. L. Graham on July 9, 1963. The flea was identified as Monopsyllus vison (Baker), a flea normally associated with the red squirrel (Holland 1949). The lynx represents a new host record for this flea. Two lynxes examined in Ontario were also found to be free of ectoparasites (Scholten et al.,1962). The results suggest a relatively low frequency of animals infected with ectoparasites. Those that have been collected from the lynx have usually been acquired from its prey, with the possible exception of Arctopsyllus setosa (Holland, 1949).

The scarcity of fleas on the lynx is no doubt linked to the habit of bedding down on the trail and the lack of regularly used dens or burrows. The nursing female would be an exception.

Scanlon (1960) reported that no lice had been recorded from the lynx; but he suspected that the species of Felicola known from the bobcat (Felis (Lynx) rufus) or a new Felicola sp. would in time be recorded from the Canada lynx. Hopkins (1960) did report a new species Felicola (Felicola) spenceri from the lynx in British Columbia. Ectoparasites reported from the lynx in the literature are listed in Table 11.

TABLE 11. LIST OF ECTOPARASITES RECORDED FROM THE LYNX;

COMPILED FROM THE LITERATURE

(Nomenclature follows Holland, 1949)

	True Host	Locality	Author
Siphonaptera			
Arctopsylla setosa (Rothschild)	Some carnivores	British Columbia	Holland, 1949
Foxella ignota albertensis (Jordan & Rothschild)	Thomomys	Alberta	Holland, 1949
Hoplopsyllus glacialis glacialis (Taschenberg)	Lepus arcticus	N.W.T.	Holland, 1949
Hoplopsyllus glacialis lynx (Baker)	Lepus americanus	British Columbia; Alberta; N.W.T.; New Brunswick	Holland, 1949
Opisodasys vesperalis (Jordan)	Glaucomys sp.	B.C.; Moscow, Idaho.	Holland, 1949 Stiles & Baker, 1934
*Orchopeas caedens durus (Jordan)	Tamiasciurus hudsonicus	B.C.	Holland, 1949
Odontopsyllus dentatus (Baker)	Sylvilagus sp.	Moscow, Idaho	Stiles & Baker, 1934
Thrassis petiolatus (Baker)	Citellus columbianus	Moscow, Idaho	Stiles & Baker, 1934
Nosopsyllus fasciatus (Bosc d'Antic)	Rattus norvegicus		Costa Lima Hathaway, 1946
Mallophaga			
Felicola (Felicola) spenceri	Lynx ?	B.C.	Hopkins, 1960

* Ceratophyllus labiatus listed by Stiles & Baker (1934) may be a synonym of O. caedens. See Holland, 1949.

Endoparasites

All carcasses, except four which were badly dessicated, and one which was received after the data had been processed, were examined for the presence of endoparasites. Trachea, lungs, heart, esophagus, stomach, intestine, liver, spleen, kidneys and urinary bladder of each individual were examined. The brains were examined in a mashed state, as the skulls were collected for other purposes. The frontal sinus was not examined. A sample of the diaphragm of every other animal was examined for the presence of *Trichinella*.

The parasites were collected, washed and preserved in AFA at the time of the autopsy, to be identified and counted later. Cestodes were identified chiefly by their rostellar hooks (Riser, 1956). Whole mounts were also made to confirm the identification. Representative hooks and whole mounts were checked against specimens at the Beltsville Parasitological Laboratories, Maryland, U.S.A. Nematodes were dehydrated and cleared in methyl salicylate if necessary.

Of the 113 specimens examined only 3 were found to be free of parasites, i.e., 97 percent were infected (Table 12). Stomach, intestine and lungs were the only organs found to be parasitized. The small intestine was the most frequently and heavily infested organ, followed by the stomach and the lungs. The three species of cestodes and one species of nematode recorded from the small intestine were also found in the stomach and the large intestine on occasion.

Taenia macrocystis Diesing, 1850 was the most common parasite. It has been recorded from the lynx before. Skinker (1935) reported that

TABLE 12. LIST OF ENDOPARASITES FOUND IN A SAMPLE OF 113 LYNXES

	Frequency occurrence	% occurrence	Site	Total Number	Highest infection
Cestoda					
Taenia macrocystis	96	85	Small intestine	3358	224
Taenia rileyi	67	59	Small intestine	413	28
Taenia pisiformis	39	34	Small intestine	891*	176
Taenia sp.	10	9		39	
Trematoda					
Alaria (*Paralaria*) sp.	1	1	Small intestine	1	1
Nematoda					
Toxascaris leonina	92	82	Small intestine	1616	58
Toxocara cati	4	4	Small intestine	5	2
Physaloptera praeputialis	2	2	Stomach	6	4
Spirocerca lupi	48	42	Stomach	535	45
Troglostrongylus wilsoni	21	19	Lungs	367	81
No parasites	3	3			

* This total is too low because the small size of the scoleces and the great numbers in which they sometimes occurred made complete collection difficult.

specimens collected from the lynx and listed as T. laticollis were incorrectly identified and were in fact T. macrocystis. Riser (1956) said that T. macrocystis was commonly found in "the lynx" in the Rocky Mountains. It is uncertain whether he meant the Canada lynx as well as the bobcat, but from the context it seems that the statement refers primarily to the bobcat. Hall (1919) listed Felis tigrina, F. yagouaroundi and Felis sp., Galictis sp., and the bobcat as additional primary hosts. One known intermediate host is listed in the literature; Sylvilagus brasiliensis (Hall, 1919). It is probable that in the present situation the intermediate host is the snowshoe hare. The high occurrence of this hare as a food item correlates quite well with the high occurrence of T. macrocystis in the small intestine. A larval T. macrocystis was in fact found in association with a partly digested snowshoe hare in one lynx stomach. T. macrocystis was found in specimens from all regions in Alberta as well as from the Northwest Territories.

Taenia pisiformis (Bloch, 1780) was the most numerous tapeworm after T. macrocystis and the third most frequent cestode. No adult specimen was found; development did not seem to go beyond a scolex with at the most a slender unsegmented neck. These were identified solely by their hooks. Considerable variation in size of the hooks was encountered (c.f. Stevenson et al., 1904). This tapeworm is not listed in the literature as having been recorded from the lynx. Holmes (personal communication) found it in a lynx collected in the Crowsnest Forest Reserve in 1958. It has been found in other cats such as the tiger (Panthera tigris) and the house cat (Felis domesticus) (Hall, 1919); Rollings (1945) reported it from the bobcat, but no mention is made as to whether the specimens found had strobila. T. pisiformis is mainly a tapeworm of canids. Freeman et al., (1961) found it to be the most common cestode of the coyote (Canis latrans) in

Ontario; it occurs to a lesser extent also in the timber wolf (Canis lupus). All tapeworms found in a juvenile coyote, caught by me during the summer of 1962 in country where lynxes and snowshoe hares were common, were T. pisiformis. Holmes (personal communication) found it in 9 of 30 coyotes and 2 of 11 timber wolves from Alberta. It is not known what prevents the development of T. pisiformis in the lynx. The cysticerci of T. pisiformis are known to occur commonly in the peritoneal cavity of the snowshoe hare. Twelve cysticerci were found attached to what appeared to be the mesocolon of a snowshoe hare in the stomach of one lynx. Infection of snowshoe hares with T. pisiformis may be quite high; 13 out of 37 hares examined by Holmes (personal communication) were found to be infected with cysticerci. Lynxes infected with T. pisiformis came from Alberta and the Northwest Territories.

Taenia rileyi Loewen, 1929, was the second most frequently found tapeworm, although its total numbers stayed well below those of T. macrocystis and T. pisiformis. This cestode was first reported and described from the Canada lynx by Loewen (1929). Fagasinski (1961) reported it from the lynx in Poland, he based his identification chiefly on the dimensions of the large and small hooks (length only) and Loewen's description of these. Riser (1956) correctly pointed out that Loewen's description of T. rileyi was a composite based on the strobila of T. rileyi and the scoleces of T. laticollis and maybe T. macrocystis. Fagasinski's (1961) identification is therefore in all probability incorrect and needs re-examination. Riser (1956) mentioned it as occurring in "the lynx" in the Rocky Mountains (see remark under T. macrocystis). The intermediate host is generally listed as unknown, but Riser (1956) examined cysticerci of T. rileyi from Peromyscus spp. Recently cysticerci have also been found

in the liver of Clethrionomys spp. (Murray, 1963). Preparations of hooks from cysticerci collected from red squirrels and labelled as T. omissa were examined and found to be hooks of T. rileyi. Microtus spp. may also be found to serve as intermediate hosts. If this is the case, there again would be a correlation between the frequency at which the intermediate hosts occur in the food list and the occurrence of the parasite. No larval T. rileyi were found in association with Microtus in the stomach. T. rileyi was collected from specimens from all parts of the area of collection.

Scoleces that had lost all their hooks and could not therefore be identified are listed as Taenia sp.

Only one trematode was collected. It could be identified with certainty only to subgeneric level; Alaria (Paralaria) sp. It is the first trematode of this subgenus recorded from the lynx although A. (Alaria) canis has been reported from the lynx by Pearson (1956).

The nematodes were represented by four genera. Most common were the nematodes parasitic in the digestive tract.

Toxascaris leonina (von Linstow, 1902) was the most numerous and frequent of the nematodes. This ascarid is cosmopolitan and has been recorded from a wide variety of carnivores, including the lynx (McClure, 1934). The life cycle is direct (Sprent, 1959) and this may account in part for its abundance.

Toxocara cati (Schrank, 1788) was found in only 4 lynxes. Infections were low and in all cases T. cati occurred together with T. leonina. T. cati is a cosmopolitan parasite of cats. It was reported

from the Canada lynx by Canavan (1931). Rollings (1945) reported it to be more common than T. leonina in Minnesota bobcats. The life cycle may be direct or an intermediate host may be involved. The larval T. cati can infect a wide range of organisms, invertebrates as well as vertebrates, which can act as intermediate hosts (Sprent, 1956). All lynxes infected with T. cati were collected in the same restricted area (Twp. 63, Rge. 3 W5th Mer.) suggesting a local pocket of infection.

Spirocerca lupi (Rudolphi, 1819) commonly parasitized the stomach, where they were found in fibrous tumors (cysts) in the wall. A single cyst was usually present, but two and three cysts were found on three occasions each. Ten cysts were found to be abandoned. No cysts were found in the esophagus or aorta, where they occurred most frequently in dogs infected by this nematode (Flores-Barroeta, 1955). S. lupi was collected from the Canada lynx before (Stiles and Baker, 1934). Rollings (1945) reported possibly this species from bobcats. It has also been collected from other carnivores in Europe and North America (Yamaguti, 1961). Transmission may require one or two intermediate hosts, the first one of which is a coprophagous insect, the second is a vertebrate. In the present cases of infection a second intermediate host was probably involved as insects are not ingested often enough (see section on food habits) to account for the frequency of infection. S. lupi infection was found in all areas in which specimens were collected.

Physaloptera praeputialis Linstow, 1899, was found in two lynxes. The nematodes were found loose amongst the stomach contents. All specimens collected were males. This genus has been recorded from the Canada lynx (Swales, 1933) and the species is listed for this host by Morgan (1941). Rollings (1945) found it in the bobcat in Minnesota. It is

not listed as having been collected from the lynx in the old world. The life cycle requires an insect as intermediate host; Blatella sp., Centrophilus sp. and Gryllus sp. are listed by Petri and Ameel in Yamaguti (1961). An additional intermediate host may be involved. Mitchell and Bigland (1960) reported larval Physaloptera sp. encysted in the musculature of Richardson's Grouse (Dendrapagus obscurus richardsonii) in southwestern Alberta. The infected lynxes were collected near Bowden and Calgary.

The lungs of 21 lynxes were found to be infected with Troglostrongylus wilsoni (Stough, 1953). The diaphragmatic lobes were most often infected, apical, cardiac and mediastinal lobes less often. They occurred singly but in the heavier infections they tended to occur in bunches, often obstructing the air passage they occupied. No obvious pathological changes in the surrounding tissue were noted, except a possible increased mucous and serous secretion. The worms were all white and it seems likely that they feed on these secretions and not on blood. This represents the first record of this parasite from the Canada lynx. T. wilsoni was first recorded and described from the bobcat (Sarmiento and Stough, 1956). The life cycle is unknown. Most specimens infected with this parasite came from the Northwest Territories; only three infected animals came from the Province of Alberta (Vega, Edson and Lac St. Anne).

The effects of the observed parasitic infestations are difficult to assess. All that can be said is that even the most heavily infected individuals seemed to be in good condition, if the subcutaneous and abdominal fat reserves can be used as an indicator.

No systematic surveys of parasites of the lynx are available to allow comparisons. A list of parasites recorded from the lynx and

some further information have been compiled from the literature for purposes of comparison (Table 13).

TABLE 13. LIST OF ENDOPARASITES RECORDED FROM THE LYNX; COMPILED FROM THE LITERATURE

		Intermediate Host	Locality	Source or Author
Cestoda	Taenia rileyi Loewen, 1929	Peromyscus (Riser 1956) Clethrionomys Microtus ? Tamiasciurus	Minnesota, U.S.A.	Loewen, 1929
	Taenia laticollis* Rudolphi, 1819	?	Doubtful	
	Taenia macrocystis Diesing, 1850	Sylvilagus brasiliensis (Hall 1919) Lepus americanus ?		Skinker, 1935
Trematoda	Alaria canis LaRue & Fallis, 1936		Ontario	Pearson, 1956
Nematoda	Toxascaris leonina (von Linstow, 1902)	Direct life cycle		McClure, 1934
	Toxocara cati (Schrank, 1788)	Direct life cycle, or 1 or 2 intermediate hosts (insect and vertebrate)		Canavan, 1931
	Spirocerca lupi (Rudolphi, 1819)	Insect and vertebrate	Washington Zoo	Stiles & Baker, 1934
	Physaloptera sp.		Canada	Swales, 1933
	Physaloptera praeputialis Linstow, 1899	Insect Grouse ?	-	Morgan, 1940
	Dirofilaria acutiuscula (Molin, 1858)	-	U.S.A.	Yamaguti, 1961

*Stiles and Hassall (1894) reported T. laticollis from the lynx. Skinker (1935) re-examined their material and found it to consist of T. macrocystis. I have been unable to find any additional records of T. laticollis in the literature. If Loewen's (1929) description of T. rileyi is in fact based partly on T. laticollis (Riser, 1956) it would be a first record from Canada lynx.

REPRODUCTION

The material used for the study of reproductive biology consisted of 36 pairs of testes and 39 female reproductive tracts.

The male material comprised 3 kittens, 24 yearlings and 9 adults. No samples were obtained for the months of March, September and October.

The female reproductive tracts included 10 from kittens, 18 from yearlings and 11 from adults. The months of March, May, June, July and October were not represented by the material. One April specimen was obtained.

Most of the specimens had been frozen for a considerable time before they could be processed. Histological examination of the material was therefore of limited use, as the tissues had undergone considerable distortion and autolysis.

The testes were slit and the tunica vaginalis removed to facilitate penetration of the fixative (Bouin's solution). Both testes of each pair were weighed after fixation to the nearest 0.1g. Most of the fixative on the surface was removed with a filter paper before weighing. A section about 5mm thick taken from the middle of one of each pair of testes was dehydrated and embedded in paraffin for sectioning. Sections were cut at 8μ. Three sections of each testis were mounted on glass slides, stained with Ehrlich's haematoxylin and eosin for examination of gametogenic activity.

The female material was fixed in 10 percent formalin and was examined macroscopically. A small number of microscopic sections was made to provide a guide in the interpretation of the macroscopic structures. Ovaries were sectioned serially by hand at about 2mm so that corpora lutea and mature follicles could be counted. The uteri were examined for placental scars.

Males

The histological deterioration of the majority of testes made a detailed assessment of gametogensis impossible. The presence or absence of spermatozoa in the seminiferous tubules and in the tubules of the epididymis could however be determined. Presence or absence of sperm in the seminiferous tubules and epididymis were recorded separately; this may be of doubtful value, as in one adult sperm was found in the seminiferous tubules and in the vas deferens but not in the epididymis.

The testes of the kittens did not have any spermatozoa. A yearling, approximately 13 months old, had spermatozoa in the seminiferous tubules but not in the epididymis. This was the youngest male in the sample showing signs of gonadal activity. No animals between 8 and 13 months were obtained.

All other yearlings had spermatozoa present. Of these 19 had spermatozoa in the seminiferous tubules and in the epididymis; 4 had spermatozoa in the seminiferous tubules only.

All adult testes had sperm, 7 had spermatozoa in the seminiferous tubules and epididymis and 3 in the seminiferous tubules only.

The relationship of the weight of the testis to the age of the

animal and the presence or absence of sperm are depicted in Fig. 6.

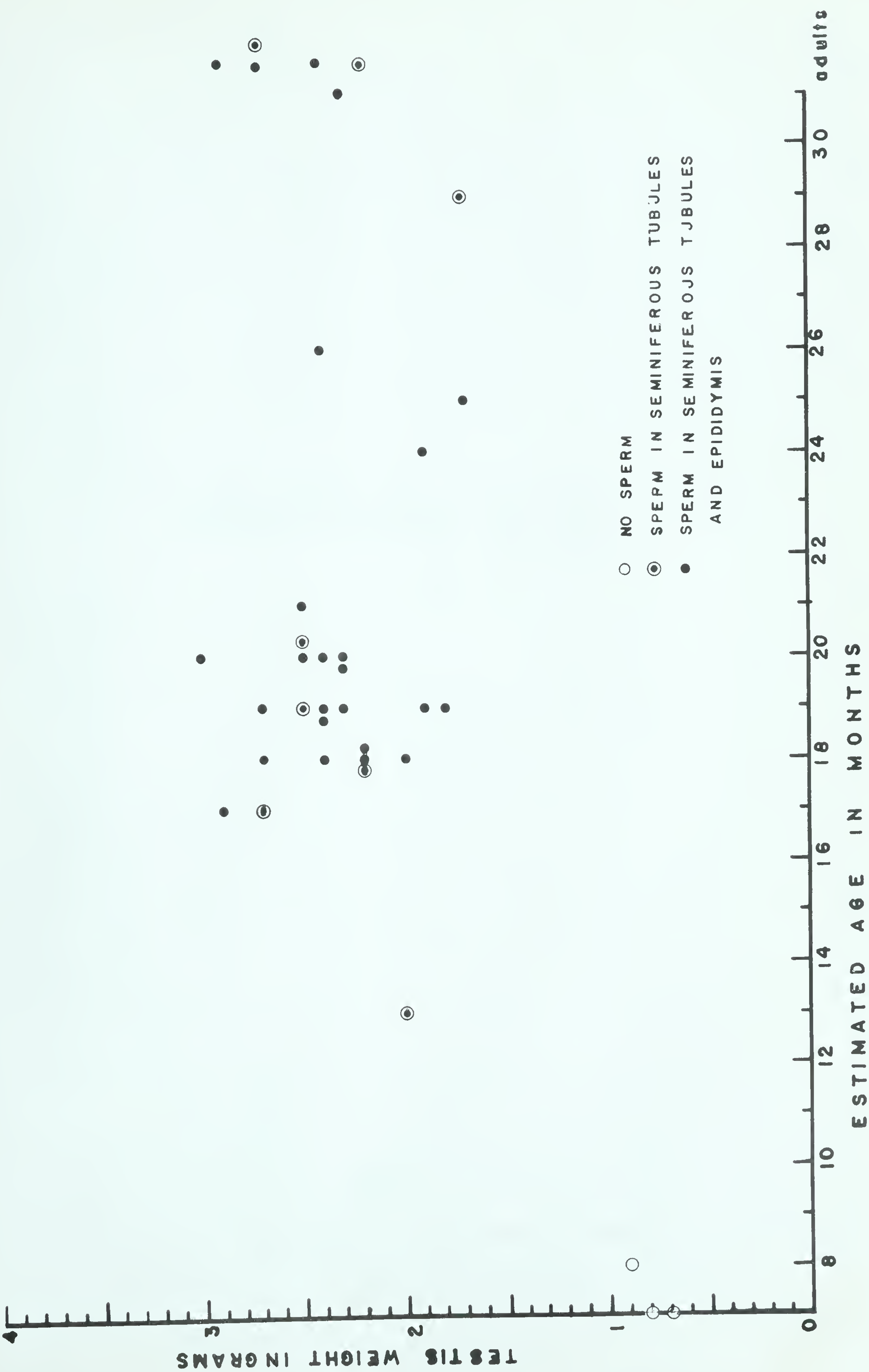
The results indicate that the testis becomes active for the first time somewhere between 8 and 14 months. Whether the animal is capable of reproduction at this time is uncertain. Saunders (1961) concluded that males are incapable of breeding in their first year. Jackson (1961) stated that young become sexually mature at the end of their first year (no reference is given but it may be based on Seton, 1910). Lindemann (1955) gave 33 months as the age at which sexual maturity is reached in the male of the European lynx; this was based on the observation of the first appearance of rutting behavior in captive animals. Ognev (1959) gave 2 years and 8 months for the male lynx in Russia.

The testes were arranged according to the month of collection to investigate the possibility of seasonal regression of weight and gonadal activity during the summer (Fig. 7).

Sperm is present in all yearlings and adults for all months of collection. The testes of one animal collected on July 25, 1962 could be studied in greater detail, as they had been properly fixed shortly after death. Spermatozoa were present in the seminiferous tubules and in the epididymis. Judging from the presence of all intermediate cell stages, spermatogenesis was in progress.

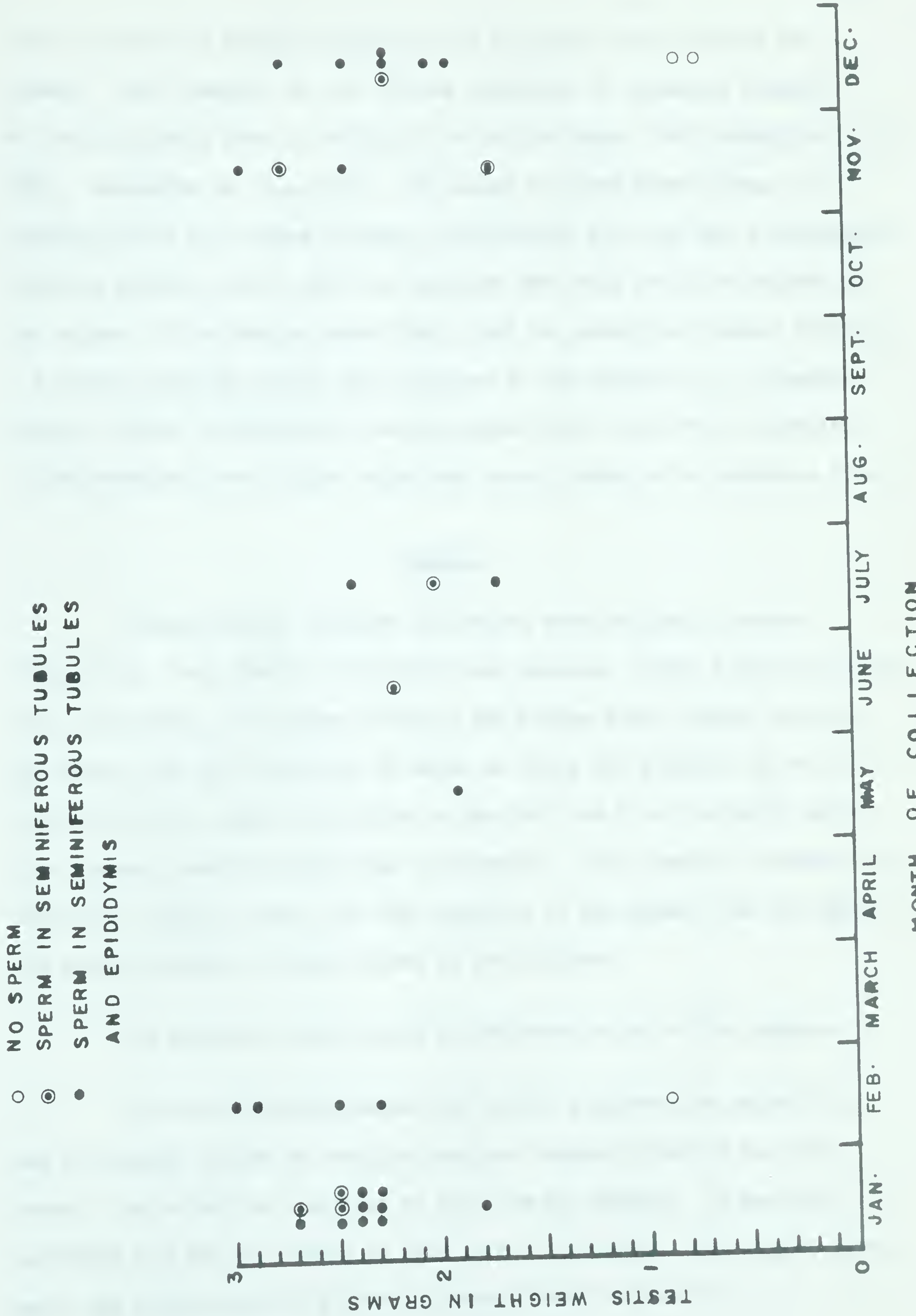
There may be a slight decrease in weight during the summer. The average testis weight for January is 2.4g (n=12); for February 2.7g (n=4); for May, June and July combined 2.1g (n=5); for November 2.4g (n=4) and for December 2.2g (n=7). The summer sample is however too small to allow any conclusions to be drawn. Saunders (1961) reported

FIG. 6 TESTIS WEIGHT PLOTTED AGAINST ESTIMATED AGE. GAMETOGENIC ACTIVITY IS INDICATED.



ESTIMATED AGE IN MONTHS
TESTIS WEIGHT IN GRAMS
0
1
2
3
4
8
10
12
14
16
18
20
22
24
26
28
30
adults
NO SPERM
SPERM IN SEMINIFEROUS TUBULES
SPERM IN SEMINIFEROUS TUBULES AND EPIDIDYMIS

FIG. 7 TESTIS WEIGHT PLOTTED AGAINST MONTH OF COLLECTION. GAMETOGENIC ACTIVITY IS INDICATED.


NO SPERM
SPERM IN SEMINIFEROUS TUBULES
SPERM IN SEMINIFEROUS TUBULES AND EPIDIDYMIS
JAN. FEB. MARCH APRIL MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
MONTH OF COLLECTION
0
1
2
3
TESTIS WEIGHT IN GRAMS

that his data may suggest regression in some adult males during the summer. Other members of the Felidae occurring in temperate climates do not apparently have a testicular cycle (Matthews, 1941; Gashwiler et al., 1961; Robinette et al., 1961). It should be noted however that in agreement with its unique northern distribution the lynx has a pronounced breeding season, and it could be expected that this would be evident in the males. It is however more likely that the selective factors favoring a seasonal breeding period were directed at the females, i.e., females having litters in unfavorable seasons would tend to be less successful in reproduction than females which had their litters at a favorable time.

Females

Three kittens of known collection date had small ovaries (Table 14); only immature follicles were present. Other kittens collected in the months of December, January and February had similar ovaries. One kitten (No. 83) collected in March or April and probably 10 or 11 months old had 3 mature follicles in the left and 7 in the right ovary, (the largest measuring about 3mm in diameter). All females 14 months and older had corpora lutea, with the exception of one female (No. 69) which had ovaries similar to those found in the kittens.

No placental scars could be detected in any of the females.

One 14-month-old female (No. 15-16) collected on August 12, had one corpus luteum in the right and two corpora lutea in the left ovary. The animal was examined at the time of capture; it was not lactating and did not appear to have done so recently. Her nipples were small and without the bare areolar patch, characteristic of

TABLE 14. MEASUREMENTS AND OTHER DATA TAKEN FROM THE OVARIES OF 39 LYNXES.

Code number	Known collection date	Measurements (in mm) Right	Left	Mature follicle R	L	Corpora lutea R	L	Estimated age
9	Dec. 5 '61	11x6x–	10.5x6x–	0	0	0	0	6 months
44	Feb. 7 '62	11x5.5x3	11.5x6x4	0	0	0	0	8 months
45	Feb. 7 '62	13x6.5x3	13x5x3	0	0	0	0	8 months
15-16	Aug.12 '62	12x8x4	18x9x6	0	0	1	2	14 months
69	Sept.23 '62	12x7x4	12x6x5	0	0	0	0	16 months
1	Nov. 6 '61	16x9x5.5	21x11x7.5	0	0	1	4	17 months
10	Dec. 5 '61	18x10x	18x8x	0	0	3	2	18 months
17	Dec.10 '61	14.5x8x5	19x11x6	0	0	1	5	18 months
24	Jan.5-14'62	15x9.5x6	19x11x9.5	0	0	1	3	19 months
25	Jan.5-14'62	14x8x6	14x8x5.5	0	0	2	3	19 months
39	Jan.10 '62	14x8x6	18x9x9	0	0	2	3	19 months
29	Jan.5-14'62	17x10x8	17x10x8	0	0	2	2	19 months
47	Feb.20 '62	19.5x10x8	20x10x9	0	0	4	3	21 months
50	Feb.18 '62	12x9x7	14x8x5	0	0	1	1	21 months
73	Apr.12 '62	14x11x	12x19x	0	0	2	1	23 months
71	Sept.2 '62	18x11x8	16x13.5x8	0	0	3	3	27 months
7	Nov. '61	15x10x5.5	17x11x7	0	0	4	2	29 months
15	Dec. '61	16.5x9x7	16x9.5x7	0	0	3	4	31 months
43	Jan.10 '62	14.5x8x6	16x8x6	0	0	1	3	31 months
3	Nov.16 '61	21x13x	20x11x	0	0	3	3	adult
42	Jan.10 '62	15x10.5x	14x7x	0	0	3	2	adult
63	Dec.-Jan.'61 '62	19.5x14x	20x11x	0	0	4	3	adult

TABLE 14. (cont.)

Code number	Known collection date	Measurements (in mm) Right	Left	Mature follicle R	L	Corpora lutea R	L	Estimated age
95	Dec.-Jan. '61 '62	16x8x	17x13x	0	0	2	5	adult
96	Dec.-Jan. '61 '62	19x12x8	18.5x10x7	0	0	2	5	adult
107	Dec.-Jan. '61 '62	16.5x14x	18x11x	0	0	4	4	adult
	Collection date not precisely known							
57	Dec.-Jan. '61 '62	12x4.5x4	12x5.5x2.5	0	0	0	0	approx. 7 months
58	Dec.-Jan. '61 '62	13x5x4	12x6x3.5	0	0	0	0	7-8 months
55	Dec.-Jan.-Feb. '61 '62	11x5x3	10x4.5x3.5	0	0	0	0	7-8 months
56	Dec.-Jan.-Feb. '61'62	12x5.5x4	12x6x3	0	0	0	0	7-8 months
61	Dec.-Jan.-Feb. '61 '62	12.5x6.5x4	12x5x4	0	0	0	0	6-7 months
65	Dec.-Jan.-Feb. '61 '62	16x6x5	15x8x5	0	0	0	0	8-9 months
82	Mar.-Apr. '62	15x8x6	16x7x5.7	3	7	0	0	9-12 months
86	Dec.-Jan.-Feb. '61 '62	14x8x5	17x12x8.5	0	0	0	4	21 months
87	Dec.-Jan.-Feb. '61 '62	13x9x5	13x8x5	0	0	3	1	18-21 months
89	Dec.-Jan.-Feb. '61 '62	18.5x9x5.5	20x11x5	0	0	1	4	18-21 months

TABLE 14. (cont.)

Code number	Collection date not precisely known	Measurements (in mm) Right	Left	Mature follicle R	L	Corpora lutea R	L	Estimated age
106	Dec.-Jan.-Feb. '61 '62	17x9x	18.7x12x	0	0	1	2	18-21 months
53	Dec.-Jan.-Feb. '61 '62	15x9x7	18x12.5x7	0	0	1	4	19-20 months
67	Dec.-Jan.-Feb. '61 '62	13x8x9	16x8x6	0	0	4	6	30-34 months
78	Mar.-May '62	15x14x7	8.5x7x3.5	0	0	5	0	21-23 months

lactating females. Other yearling females did not show evidence that they had been pregnant. The presence of corpora lutea in this case, therefore, does not necessarily indicate that the animal bred or was pregnant. It is possible i) that the animals did not breed and that the corpora lutea resulted from spontaneous ovulation, or ii) the animals did breed, but pregnancy did not result. If ovulation is induced in the lynx as it is in the domestic cat (spontaneous ovulation however, does occur in the cat, Haltenorth, 1957) breeding seems to be a necessary prerequisite for the development of the corpora lutea. In the second case the absence of pregnancy could be explained by the fact that the follicles were non-functional.

The presence of corpora lutea in the yearling females needs further study.

Saunders' (1961) findings suggest that kittens do not breed. The ovaries of two animals, considered to be yearlings, that he examined are not recorded as having any corpora lutea. The data available for the Eurasian lynx vary, but all agree that breeding does not occur in the first year. Ognev (1959) gave 2 years and 8 months as the time of sexual maturity. Lindemann (1955) reported estrus to occur for the first time at 21 months.

All adult females examined had corpora lutea. No distinction was made between non-functional and functional corpora lutea (Duke, 1949), as no obvious differences in color were noted. This could be partly due to discoloration caused by tissue deterioration. The average number of corpora lutea in adult ovaries was higher than in ovaries of yearlings. It is possible that the presence of corpora lutea of the previous season

explains this difference. In both yearlings and adults the left ovary had a higher number of corpora lutea than the right ovary (Table 15).

TABLE 15. THE NUMBER OF CORPORA LUTEA IN YEARLING AND ADULT LYNX OVARIES

	Yearlings		Adults	
	Right	Left	Right	Left
Total	31	40	33	40
Mean	1.94	2.50	3	3.64
n	16		11	
Standard deviation	1.13	1.32	.95	1.23

SUMMARY

1. This study of the biology of the Canada lynx was begun in September 1961 and concluded during the summer of 1963. The lynx population was at a high level during the period of study, and probably passed through a peak. During this time 118 carcasses were received or collected.

2. The age and sex ratios of samples from the mainly agricultural and urban districts (considered unfavorable habitat) and from districts with a higher proportion of forest including those from the Northwest Territories (considered favorable habitat) were compared. The proportion of yearlings and males was significantly higher than expected in unfavorable habitats, suggesting that yearlings are chiefly responsible for range extension during periods of high population pressure, and perhaps it also suggests a greater mobility of males than females.

3. Standard measurements and weights are given. Selected skull measurements were compared with similar measurements from Newfoundland and Alaska. Slight but significant differences could be established between Alberta and Newfoundland animals. Whether real differences exist between Alberta and Alaska is still uncertain.

4. The ossification of the long bones of the fore limb was investigated. Kittens, yearlings, and 2-year-olds up to about 31 months could be aged, if the date of collection was known. The sequence of ossification of the different epiphyses is described. The epiphyses

of the elbow joint close in the latter half of the first year of life; the proximal epiphysis of the humerus and the distal epiphyses of radius and ulna close at the end of the second year of life. Ossification is completed in the third year of life. Humerus length plotted against estimated age indicates termination of growth in length of this bone around 24 months of age.

5. Eruption and replacement of teeth was investigated. The first milk teeth appear at about 17 days of age. Milk dentition is completed between 36 and 60 days. Replacement by permanent teeth starts sometime between 60 and 120 days of age. Complete permanent dentition is acquired between 240 and 320 days of age. Root canals close during the second summer of life. Eruption and replacement of teeth were compared with data published for the European species. Wear on the permanent teeth could not be used to estimate age and cemental annuli were not found.

6. Molt was studied on the basis of pelts and observation of captive animals over the period of almost one year. There seems to be only one molt starting in spring (March) and extending into early summer. Attainment of the winter coat seems to be due to continued growth of hair during the summer and early fall.

7. Stomach and gut contents were saved and analyzed. Snowshoe hare was found to be the most important food item followed by microtine rodents. Comparison of results with other areas is made and discussed.

8. Parasites were collected and identified. A flea was the only ectoparasite found. Endoparasites were found in stomach, intestine and lungs. Three species of tapeworms, 5 species of nematodes and 1 trematode were found.

9. Thirty-six pairs of testes and 39 female reproductive tracts were studied. First signs of gonadal activity were found in a male estimated to be 13 months old. Ovaries of yearling females were found to contain corpora lutea, but no evidence was found that females breed at the end of their first year. Further study is needed. The attainment of sexual maturity in both sexes is discussed and compared with available data for the European species.

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